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ABSTRACT

Because the Navy's computer-managed instruction (CMI) system has experienced problems with prolonged system response times (RT) and excessive downtime (DT), a survey of Naval personnel was conducted to determine current and near-term CMI system instructional requirements. Questionnaires were sent to instructors, training program coordinators, system management personnel, instructional program developers and evaluators, and computer personnel. Based on information collected, five system upgrade alternatives that would satisfy instructional requirements and cost estimates for these alternatives were developed. It was recommended that the CMI upgrade effort should include adding automated support for group-paced instruction, which should result in a system with no more than 5% DT; a systems analyst should identify precise causes of system malfunctions and provide computer specifications for group-paced instruction; the Chief of Naval Education and Training (CNET) should coordinate all CMI computer programs; and training program coordinators should be knowledgeable about CMI reports for their courses. A seven-item bibliography, a sample questionnaire, lists of areas requiring empirical verification and preliminary instructional system specifications, descriptions of general instructional system functions, and a report distribution list are provided. (ESR)

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UPGRADED NAVY COMPUTER-MANAGED INSTRUCTION: ANALYSIS OF REQUIREMENTS FOR AND PRELIMINARY INSTRUCTIONAL SYSTEM SPECIFICATIONS

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UPGRADED NAVY COMPUTER-MANAGED INSTRUCTION: ANALYSIS OF REQUIREMENTS FOR AND PRELIMINARY INSTRUCTIONAL SYSTEM SPECIFICATIONS

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FOREWORD

This analysis was performed within Advanced Development Subproject Z1176-PN.01 (Improving the Navy's Computer-Managed Training System), under the sponsorship of the Deputy Chief of Naval Operations (Manpower, Personnel, and Training) (OP-01). It supports Navy Decision Coordinating Paper Z1176-PN and its objective of improving the technical training pipeline.

The CNET/NAVPERSRANDCEN Task Group reviewed a draft of this report on 15-16 April 1981. This report reflects any changes emanating from that meeting.

This report documents the results of an extensive analysis of the requirements for the Navy's Computer-Managed Instruction (CMI) system. The analysis was part of the effort of a multiorganization task group aimed at improving the CMI system. The report includes revisions coming from the Upgrade Task Group meeting held 15-16 April 1981 at Pensacola, Florida. Other members of the task group, who contributed substantially to this analysis include: Mr. John Hassen and Mr. Ed Scheye (CNET N-9), Mr. Bill Ottendorfer (CNET N-7), Mr. Wilson Thomas, Mr. Gordon Crawford, and Ms. Phylis Salop (CNTECHTRA N-1), CDR Gloria Holmes, Ms. Diane Kalivoda (CNTECHTRA N-63), Mr. Ernest Owens (CNTECHTRA N-3), Mr. Charles Tilly, Mr. George Buzinki, and Mr. Larry Snell (MIISA, Memphis Detachment), Mr. Charles Morris (TAEG), and Dr. Charles Lindahl (NTEC).

Appreciation is expressed to all members of the CMI System Upgrade Task Group, and to the many individuals at the technical schools and training program management levels who provided the necessary information for this report.

JAMES F. KELLY, JR.
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SUMMARY

Problem and Background

As the Navy's computer-managed instruction (CMI) system has grown in size and capabilities, CMI schoolhouses have experienced problems with prolonged system response times (RT) and excessive downtime (DT). These deficiencies slow the flow of students through the training pipeline. Additionally, computer system requirements have grown beyond those included in the original system design.

The Chief of Naval Education and Training (CNET) recognized the need to mount a direct effort to reconsider the entire scope of system requirements and improve the system's operation. Accordingly, CNET and the Navy Personnel Research and Development Center (NAVPERSRANDCEN) established a joint CMI System Upgrade Task Group to determine the requirements for an improved CMI system.

Objectives

The objectives of this effort were:

1. To determine current and near-term CMI system instructional requirements and provide preliminary instructional system specifications.

2. To develop alternative system upgrade approaches that would satisfy the instructional requirements.

Approach

A CNET/NAVPERSRANDCEN task group was established in October 1980 to plan for an instructional system requirements analysis. To obtain the requirements information, NAVPERSRANDCEN developed and administered questionnaires to and conducted interviews with personnel at CMI and non-CMI technical training "A" schools, Chief of Naval Technical Training (CNTECHTRA) Training Program Coordinators, CMI system management personnel, Navy instructional program developers and evaluators, and computer personnel from the Management Information and Instructional Systems Activity (MIISA), Memphis Branch Office. The survey results were integrated into information and problem summaries for each organizational element in the CMI system. By using the information summaries and making contact with MIISA personnel, CMI system upgrade alternatives were developed.

Results

1. The major CMI system deficiencies perceived throughout the CMI community are prolonged RT and excessive system DT.

2. CMI schools are satisfied with the kinds of CMI capabilities available but are generally concerned with system reliability.

3. MIISA has taken immediate short-term actions to relieve RT and DT problems, but this has altered the schools' CMI capabilities somewhat.

4. A need for ADP support of group-paced instruction was identfied and the instructional requirements were specified.

5. Instructional requirements for an expanded capabilities CMI system were specified.

6. Six CMI upgrade alternatives were specified with rough cost estimates provided for each.

7. Given the constraints of limited time and resources, the recommended upgrade alternative consists of developing the system to continue the current CMI functions. However, reliability should be improved (no more than 5 percent DT at the learning center), and automated data processing (ADP) support should be added for group-paced instruction. No DT period should exceed 10 minutes duration until switch to a backup mode is accomplished nor should there be more than four interruptions per day per shift.

Recommendations

1. CNET should continue the CMI upgrade effort to resolve RT and DT deficiencies. The upgrade effort should include adding ADP support for group-paced instruction. This short-term upgrade effort should result in a system with no more than 5 percent DT at the learning center equipment cluster, even when the host computer is down.

2. As part of the upgrade effort, MIISA should direct a systems analyst to identify precise causes of system malfunctions, and to provide computer specifications for the CMI and ADP supported group-paced instruction requirements.

3. CNET should coordinate all CNET computer programs that affect data file structures and system operation on the CMI computer.

4. CNTECHTRA should ensure that Training Program Coordinators are knowledgeable about CMI reports for their courses.

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INTRODUCTION

Background

The current Navy computer-managed instruction (CMI) system was based on a prototype system design developed by the Navy Personnel Research and Development Center (NAVPERSRANDCEN). Instructional requirements used to specify the current system were determined during the early 1970s. Since that time, the system has been expanded to perform functions not considered in the original design, and the computer, which was originally dedicated to support CMI, is now being used to support a number of additional information systems. Meanwhile, more courses and students were added until Navy CMI is presently serving approximately 9000 students daily. A major new requirement to provide automated data processing (ADP) support for group-paced courses is also being considered.

Problem

During the last year, the CMI schoolhouses have experienced problems with deteriorated system response time (RT) and excessive downtime (DT), making it difficult for students to have tests graded and receive study assignments in a timely manner. This inefficiency slows the flow of students through the training pipeline. Although a number of short-term actions have been directed toward solving these problems, a continued expansion of the system may again lead to degraded operations.

Both the Chief of Naval Education and Training (CNET) and the Chief of Naval Technical Training (CNTECHTRA) recognized the need to mount a direct effort to improve the system's operation and to reconsider the entire scope of its instructional requirements. As a first phase of this effort, it was necessary to determine the requirements for an upgraded system and to provide the specifications for alternative instructional systems. It was assumed that, should a major system redesign effort be warranted, the selected design alternative would be implemented with relatively limited funding and personnel resources.

Objective

The objective of this effort was to identify current and near-term CMI system instructional requirements, and to provide preliminary instructional system specifications that would satisfy the requirements and ensure that planned expansion, in both size and capabilities, could proceed without causing degraded system operation. The information concerning alternative system designs is intended to aid CNET in deciding the optimal approach for upgrading CMI, taking into account both the benefits of added capabilities and improved system operation and the cost of additional hardware and personnel.

APPROACH

Joint Task Group

A joint task group was established in October 1980 to develop a plan for determining instructional system requirements and for providing supporting information for CNET for use in selecting an approach for upgrading the CMI system. The group was comprised of staff from the following organizations: CNET (N-2, N-7, N-9, 015); CNTECHTRA (N-1, N-63); the Management Information and Instructional Systems Activity, Memphis (MIISA), which operates the computer; the Training Analysis and Evaluation Group (TAEG); the

Navy Training Equipment Center (NTEC); and NAVPERSRANDCEN. Co-chairmen for the group were from CNET N-9 and NAVPERSRANDCEN. A list of specific task group members attending the initial meeting is provided as part of Appendix A, which lists all Navy information sources contributing to this effort.

Procedure

To elicit information regarding system problems and user requirements, the task group surveyed all components of the instructional system including: the schools (including those that are not supported by CMI), management, MIISA, the instructional program development centers (IPDCs), and research organizations. The survey was conducted by means of a series of questionnaires developed by NAVPERSRANDCEN. CNTECTRA Code N-1 (the CMI system manager) served as the point of contact for the distribution and return of questionnaires from the many schoolhouses, training program coordinators (TPCs), and other staff organizations within the Naval Technical Training Command. Questionnaires for other organizations were distributed individually and were frequently completed during personal interviews. Most questions were open-ended so as to ensure the broadest possible coverage of system problems and user need.

The task group also requested extensive data on each course from available Navy information systems. These data were used as background for interpreting certain responses to the questionnaires.

Analyses

The survey results were integrated into summaries representing the consensus at each major echelon and organization comprising the CMI system. Accordingly, information on problems and needs are presented from the perspectives of: the technical training schoolhouses, training program management at CNTECHTRA, CMI system management at CNTECHTRA, the computer organization (MIISA), and the instructional program developers/evaluators (IPDC/CNET/CNTECHTRA). Technological opportunities for CMI were identified based on survey information obtained from research organizations and personal contacts with experts from participating task group organizations and other civilian and military agencies.

Information from the survey was used as a basis for developing instructional functions specifications for (1) an upgraded CMI system and (2) a system to provide ADP support for group-paced instruction. These functional specifications, in turn, were used as a basis for developing alternative system configurations. Rough estimates of costs for each configuration were provided by MIISA.

SUMMARY OF SURVEY INFORMATION

Information from Technical Training Schoolhouses

Questionnaires were sent to all schools where CNTECHTRA-controlled AI and AP courses were being taught. Schools already supported by CMI were asked to identify problems with the existing system, to rate the utility of available CMI reports, and to suggest instructional system modifications that might increase CMI effectiveness. A copy of the CMI course questionnaire is provided in Appendix B.

The questionnaire for schools that did not have CMI courses focused on possible ADP support for two general areas: (1) administrative requirements (developing and using

records and preparing reports), and (2) testing requirements (scoring tests and processing and storing the results). Instructions for the questionnaire asked the respondent to develop a school consensus for each question. While the nature of the questions prevented elaborate statistical analyses, the obtained information was readily summarized and is provided in the following paragraphs.

CMI-Supported Schools

Personnel from nine CMI-supported courses responded to the questionnaire: Aviation Machinists Mate (AD), Aviation Fundamentals (AFUN), Avionic Technician (AV), Basic Electronics and Electricity (BE/E) (4 locations), Interior Communications Electrician (IC), and Radioman (RM). Responses differed greatly as to the frequency and severity of the ratings on the two major operational problems (RT and DT), and the ratings on other deficiencies. One of these other deficiencies, CMI course coding, was mentioned with some degree of frequency, but it was never rated as more than a minor problem. The remaining problems listed were few in number, course specific, and also rated as minor.

Personnel from the CMI schools were asked to list any new functions or capabilities that should be considered for the CMI system. In general, there was little commonality among these suggestions. Several respondents suggested that it would be helpful to have faster RTs for information that would be used during an Academic Review Board (ARB), and that some of the existing CMI reports used for that purpose, particularly the Student Response History, could be made more useful. Several respondents indicated a desire to continue using the NAVPERSRANDCEN-developed Incentive Charts, which were recently evaluated during an operational test. Most of the remaining comments pertained to relatively minor revisions in certain reports (e.g., list Navy and Marine Corps students separately, or flag Job Oriented Basic Skill (JOBS) students).

Each respondent was asked to rate the utility of each of the 18 reports that are routinely available from the CMI system. Separate ratings were made for learning center personnel and for administrative and managerial personnel. Detailed responses regarding report utility are provided in Table 1. As shown, although the utility ratings for many of the individual reports were quite variable, each report was rated as Very Useful by at least three of the schools. As noted previously, several respondents suggested minor report revisions, but indicated no real need for additional kinds of reports.

The three Academic Remediation Training (ART) programs, located at Navy Training Centers in San Diego, Great Lakes, and Orlando, are also supported by the CMI system. However, their needs differ considerably from those of conventional CMI courses, because of their combined individualized and group-paced form of instruction and the testing procedure used to select students. The ARTs were similar to other CMI courses in their ratings of slow RT and excessive DT as the major system deficiencies. The ARTs also cited several problems arising from their unique form of instruction (e.g., a need for multiple study assignments). The ARTs used few of the routine CMI reports. However, both the ARTs and CNTECHTRA Code 017, manager of the ARTs, indicated a substantial need for reports and summaries that are not provided by the current system. The desired summaries require access to demographic data that are not recorded by the current system, or to performance data in subsequent courses or in the fleet. This is an example of the need to provide an automated data management capability that extends across the training/fleet pipeline and is centrally managed.

In summary, questionnaires from schools now on the CMI system describe an overwhelming concern with slow RT and excessive system DT. While other problems do exist, they are far less important to the schools. In general the CMI schools are satisfied with the current set of CMI instructional functions.

Table 1

Ratings of Routine CMI Reports by Course Personnel

Report	Learning Center Personnel			Administrative and Managerial Personnel		
	Very Useful	Moderately Useful	Not Useful	Very Useful	Moderately Useful	Not Useful
Student Learning Guides	8	1	0	1	4	4
Daily CMI Student Progress Reports	9	0	0	9	0	0
Deficient Progress Report	4	1	4	6	2	1
Accelerated Progress Report	1	5	2	5	2	2
Trend Analysis Report	1	2	6	2	5	2
Extra Study Report	3	3	3	3	3	3
Learning Center Status Report	1	6	2	7	2	0
CDP Distribution	0	0	9	4	2	3
School Rosters	4	2	3	9	0	0
Graduation/Drop Rosters	0	4	5	7	2	0
Projected CMI Graduation Report	0	3	6	4	2	3
Student Performance Summary	0	3	6	6	1	2
Monthly Student Flow Report	0	1	8	6	1	2
Module Distribution Report	0	2	7	3	5	1
Response History Print	3	1	5	6	3	0
Student Status Matrix	1	2	6	4	2	3
Item Analysis Report	1	1	7	6	3	0
Module Performance Analysis Report[a]	0	0	8	6	1	1

[a]This report was not available in the AV course.

Non-CMI Supported Schools

Non-CMI school respondents were asked to indicate which of their records, reports, and analyses might be handled by a computer, and to estimate the number of man-hours per month now devoted to each activity. Total estimates ranged from 6 hours per month to 885 hours per month. Estimates tended to vary with the average number of students on board (AOB), but there were still substantial variations--from .1 to 4.0 hours per student on board. Part of this variation was probably due to real differences in the reporting requirements for different organizations. Another part was due to differences in attitude; some respondents listed activities that might be quite awkward for a computer, while

others failed to list activities that are required in all courses and that are handled routinely by computers.

In general, the responses serve to document a fairly substantial need for computer support in non-CMI courses. Some of this need is already being met through the use of local data processing facilities such as Scantron scoring devices coupled with microcomputers. TAEG is presently developing the functional specifications for such a facility to be used by the Apprentice Training program at NTC, Great Lakes. The TAEG specifications would probably be applicable to all Apprentice Training programs. Computer support of the kind now in existence tends to be highly variable and nonprogrammatic. Most of the perceived needs for ADP are not being met at all.

Each non-CMI respondent was asked to provide information on the kinds and frequency of tests they administer. The frequencies reported were extremely variable, ranging from one short test every few weeks to approximately six tests each day. The higher frequencies were typical in the individually-paced courses, but they were also found in some of the group-paced courses. Much of this variability is due to differences in the intended function of the tests. In some courses, it appears that the sole purpose of the tests was to provide occasional ranking of students. In others, the tests were used to facilitate learning, to ensure mastery of training objectives, and to evaluate the quality of instruction. Generally, the majority of non-CMI courses administered informal tests or quizzes two or three times a week and formal tests about once a week.

The kinds of questions used on these tests also differed widely from course to course. The majority of items were multiple-choice and true-false questions that could easily be scored by automated means. A considerable number of matching and fill-in items of both a numerical and alphabetical nature were also used. Many of these items could probably be converted to a format suitable for automated scoring. In fact, the possibility of such a format conversion was mentioned by several respondents. Finally, there were several courses in which many tests could be handled through the use of special equipment (e.g., optical character readers) and special ADP programs (e.g., programs similar to the one used for scoring teletyping testing in the RM "A" course).

Attitudes toward automated test scoring appeared about evenly divided for and against, with the more favorable attitudes occurring among courses with large AOBs. In fact, one of the most frequently mentioned responses for rejecting automated scoring was the belief that it would not be cost effective (or simply not worth the trouble) in the very small courses. There was also a feeling that automated test scoring would diminish the rapport between student and instructor. Why this relationship between rapport and automated scoring should be more of a problem in a small course than in a large course is not clear from the questionnaire responses. Finally, it appeared that some respondents reacted negatively toward the possibility of automated test scoring simply because they did not want CMI, even though the questionnaire stressed the point that automated scoring is not synonymous with CMI. The fact that automated test scoring of one kind or another is already being used in several of the courses is indicative of the general level of acceptance, if not outright demand, for ADP support. Attitudes toward automated scoring and the use of a computer to store test results tended to be correlated, but the relationship was far from perfect. Some respondents wanted automated scoring for quizzes, but did not want to retain the results. Other respondents wanted to store data from tests, even when the tests would not be scored by automated means. It was clear that many of the respondents had not perceived the possibility of storing test data as a means of satisfying the schools' continuous reporting requirement. Finally, several respondents indicated an interest in generating tests automatically from a stored pool of test questions.

By chance, questionnaires were sent to several schools with A2, C1, and C7 courses. These courses had small AOBs, and their responses tended to be similar to those of the smaller A1 courses; that is, a number of them felt that their requirements were not sufficient to justify a computer-based system for either administrative support or test scoring. Courses of this kind tend to be physically clustered into groups with related subject matter. In many cases, these clusters are at major training sites (e.g., Memphis or San Diego); in other cases, they are relatively isolated (e.g., Mare Island). In either case, it may be suitable for the courses within a cluster to share elements of a computer system, even though ADP support could not be justified for each individual course.

Although questionnaires were not sent to the Apprentice Training courses, information from CNET[1] indicates that the total AOB is large (about 2300), that testing requirements in a batchmode are substantial, and that automated test scoring is either available now (e.g., Great Lakes) or is planned for the near future (e.g., San Diego). The TAEG effort to develop functional specifications should apply to all apprentice training sites, as mentioned previously.

In summary, the questionnaires from non-CMI courses document a fairly extensive need for ADP support, even if it were limited to functions that are obvious, such as scoring multiple-choice tests, and were provided only for courses that actively request ADP support. The total ADP requirement for all non-CMI courses is probably more extensive, but comprehensive documentation of these requirements calls for a more extensive analysis with greater resources than were available during the preparation of this report.

Information from Training Program Coordinators at CNTECHTRA

Questionnaires were sent to all TPCs on the CNTECHTRA staff to obtain input from mid-level management. The TPCs were asked to consider the possibility of ADP support for group-paced courses and to indicate the kind and amount of support that might be needed. TPCs with CMI courses were asked, in addition, to list deficiencies of the existing CMI system, suggest improvements, and indicate their use of standard CMI reports. To date, only 12 responses have been received. Since those that were received tend to be similar to those obtained from the individual schools, the absence of a more complete return may not be serious.

Several TPCs provided extensive lists of requirements for non-CMI courses that might be met by a computer; others limited themselves to brief general discussions. A majority of the responses were positive with respect to both automated administrative support and testing. There were some reservations about ADP support for small courses or for courses that rely almost exclusively on performance testing. However, one TPC, who manages a sizable training program, felt that "there is nothing to be gained with computer support in this area." One TPC discussed the possible use of computer-driven training devices. The few TPCs who commented on how ADP support might be provided favored local computers operated under local control.

Most of the CMI TPCs cited DT as the single serious problem with CMI. They offered no suggestions for additional capabilities. The two TPCs who responded to the question on report utilization listed only the Performance Summaries and the Monthly Student Flow Report. This low level of utilization suggests that few reports are useful at this level of

[1]CNET ltr Code N-526 of 11 Jan 1980 to CNTECHTRA. Subj: Computer-Managed Instruction (CMI) Apprentice Training Support Requirements.

management, or that the TPCs are not aware of the reports that are available. Since the TPC for the BE/E schools uses the CMI reports extensively in making management decisions, it is apparent that the CMI data can be of great value at this level.

Information from the CMI System Manager at CNTECHTRA

Extensive information was obtained from the CMI system manager's office at CNTECHTRA (N-8) regarding: description of current functions, current system deficiencies, new functions desired, areas requiring empirical verification to assure system optimization, and requests for CMI data. The extent of this information obtained from the system manager reflects the fact that he becomes involved in many problem calls from users, handles all requests for CMI data, serves as the interface between the training community and the computer organization, and is responsible to management for system operation. The description of current functions was used in evaluating responses from other components of the CMI community, but was too extensive for direct inclusion in this report. The interested reader can find detailed descriptions of system functions (e.g., student registration, training path selection, test scoring and feedback, remediation and prescription, student progress tracking, and course completion) in Section 1 of CMI User Manual 0 (Guidelines for the use of the Navy Computer-Managed Instruction System).

System Deficiencies

The system manager listed the following items as deficiencies:

1. Excessive DT and the inability to assess DT accurately at the individual school level.

2. Slow RT and the inability to measure RT at individual schools.

3. Lack of flexibility in test item format (e.g., limited to multiple choice).

4. Lack of a resource allocation and scheduling capability for assigning students to limited equipment or space in certain courses.

The inclusion of the RT and DT problems on the system manager's list no doubt reflects the continued concern expressed to the N-8 office by the individual schools over this past year. The needs for greater flexibility in test item format and a resource allocation capability have been noted by N-8 for several years. The severity of these deficiencies has become more apparent as they have been encountered by more instructional program development efforts.

The following items, although not listed as deficiencies, were listed as areas requiring empirical verification to assure system optimization.

1. Criteria for selecting an instructional delivery system.

2. Guidelines for designing the optimum learning center.

3. Guidelines for instructional design in computer-managed courses.

Because these three areas are relevant to a broad scope of training problems, the detailed N-8 comments are included in Appendix C.

N-8 also discussed the problem of CMI course coding. Inefficient or incomplete testing of the initial course codes results in incorrect codes being implemented on an

operational basis. This leads to a loss of time for both students and instructors, since the instructor must determine the coding problem and then get it corrected. N-8 recommends, and the task group supports development of an on-line coding capability that could have built-in debugging steps to assure adequate testing of course codes prior to use with students. Such a capability would be essential in the absence of a centralized coding facility.

There are also problems in meeting special requests for CMI data. During the period 1 October 1980 through 1 March 1981, N-8 received about 20 special requests for CMI data from CMI users in CNTECHTRA and from other organizations such as NAVPERS-RANDCEN, TAEG, CNET, and CNO. Each of these requests involved a special programming effort by MIISA personnel and, because of conflicting demands, required about 30-40 days to satisfy. The structure of the CMI data base is such that summarized information cannot be obtained easily from the system. This limitation is due to the sequential method in which CMI data are stored and is inherent to the current system architecture.

Areas for Potential System Improvement

The following functions were suggested as additions to the system:

1. A resource allocation and scheduling capability for assigning and tracking limited resources such as equipment and lab stations.

2. A training path selection capability that can adjust to limited resources by making alternative assignments.

3. A capability for predicting course completion that can adjust for variations in student assignments caused by limited resources.

4. Development and evaluation of procedures for using alternate test item formats such as constructed response questions.

5. Development of ADP support for group-paced instruction including test scoring, information reporting, and student progress management.

6. Ability to summarize and extract performance information readily for both individuals and groups.

7. Ability to relate individual test items to objectives, so as to improve the evaluation of training and the use of feedback from the fleet.

8. On-line testing.

9. Computer-generated tests.

10. An on-line capability for course coding, with automated debugging procedures.

Although the problems and suggestions expressed by the system manager are similar to those expressed by school personnel, two major differences in perspective are worthy of note. First, the system manager places a greater emphasis on the use of an allocation and scheduling procedure that might eliminate bottlenecks due to limited resources. Second, he perceives a greater need to improve the guidelines for course design. It should be obvious to the reader that, no matter how efficiently a CMI system operates, student

progress and achievement will be deficient if either the instructional materials or the course design is defective.

In summary, the system manager feels that the major problems with the current system are slow RT and excessive DT, and that the major system limitations are the lack of test item flexibility, the lack of a resource allocation and scheduling capability, inadequate CMI course design guidelines, and an inadequate data management capability. Without better information about design alternatives, arbitrary guidelines may be systematically degrading the effectiveness of each course added to the system.

Information from MIISA--The Computer Organization

Information regarding CMI system problems was obtained from MIISA during personal interviews with staff and from a questionnaire. The questions focused on problems with CMI and their possible solutions, the extent of support for systems other than CMI, and information regarding the cost and scheduling of alternate CMI system design options.

MIISA recognizes the DT problem, but points out that this problem is much greater in the classroom than at the central computer site. The central computer is operating well within its contractual maximum of five percent DT. In fact, recent analyses indicate the Mainframe computer is down only one to three percent of the time. Although there are obviously other problems in the chain between the central computer and the equipment in the learning centers that contribute to the DT experienced by students and instructors, isolating the precise location and cause of these problems is extremely difficult. Similar diagnostic problems exist for the slow RT. Recently, so many changes have been made to improve RT that it is impossible to specify the exact effect of each change. MIISA recognizes the possibility that the computer system is virtually saturated with its present student and course load.

Three factors that may be causing problems will be discussed:

1. The loading of a computer that was originally dedicated to CMI for jobs such as military payroll and MILPERSIS may well be interfering with system operation. The full list of data processing functions supported by the Memphis computer, other than those directly associated with CMI, is provided below:

• MILPERSIS	Computer Directed Training System
• STDM	Corps of Engineers
• NITRAS	Personnel
• 100 Application Programs, NAS Memphis	NMPC Accounting
• Military/Civilian Payroll	Resources Management System
• 3-M	

From this list, it is obvious that there is a substantial load beyond that imposed by CMI. Any difficulties created by competing demands on the computer are exacerbated by the absence of formal priorities for the different processing systems. Although it is frequently asserted that the CMI evaluation (EVAL) program has high priority, there are certain situations in which EVAL defers to the other systems such as MILPERSIS. (CNET should provide formal guidance for establishing system priorities.)

2. Because of the design of the EVAL program itself, all information must be processed sequentially. As a result, when the program becomes saturated, data are backed up in the buffers and RT increases. Contacts with the MIISA staff indicate that the

resolution of this limitation would require the redesign of the EVAL program, if not the entire system software.

3. CMI functions now assigned to the computer go far beyond those originally envisioned. When the system was first developed, it was modeled after a design for a relatively small system. While efficiencies were built in the full Navy system, the full gamut of kinds of courses to be supported (e.g., highly individualized courses with frequent testing and remediation assignments, or large numbers of tests to be scored all at once, and automated teletyping test scoring (Radioman "A" school)) were not considered in the design structure. Although MIISA has improved the software program to accommodate these additional functions, a major system redesign may be necessary both to resolve system problems and to permit an orderly addition of other courses or functional capabilities.

Failures throughout the system leading to DT at the terminals were caused for a variety of reasons. The reasons for these failures, and the approximate percent of DT at the terminal, are listed below:

	Reasons	Percent Downtime at Terminals
1.	Terminet failures, all sites.	2%
2.	OPSCAN failures, all sites.	3%
3.	DT due to MILPERSIS failures.	2%
4.	DT due to communication problems.	3%
5.	DT due to computer hardware failures.	3%
6.	DT due to operator error.	1%
7.	DT due to equipment/software changes.	1%

It should be noted that MIISA has recently made a number of changes to alleviate the RT and DT problems. Current analysis shows an average RT of 2 to 10 seconds, although some RTs are still as long as 2 minutes while tapes are being changed. This occasional long RT indicates the continued existence of an RT problem. Additionally, the RT improvement that has been achieved has come about at the removal of some of the school's capabilities. For example, schools are now somewhat limited to when they can register students. If this limit on registration prevents students from beginning study on the day they arrive, it may cost the training command the remainder of the first day when the student gets to a CMI school. While the changes can improve immediate system functioning, MIISA recognizes the need to reach a permanent solution that will permit full-system function at the schoolhouse level and allow planned system growth without further deterioration of system operation.

A major support problem facing MIISA involves the lack of course coding resources. Although the original CMI course implementation schedule has slipped considerably, present course coding requirements exceed the MIISA capability. A major issue involves deciding whether to assign coding responsibility to MIISA on a centralized basis or task the IPDCs to assume coding tasks. At present, coding quality is maintained when performed at MIISA-Memphis by experienced coders. Problems of course coding occur frequently when performed outside MIISA due, in part, to the high turnover of non-MIISA coders, who are relatively inexperienced.

Information from the Area of Instructional Program Development and Evaluation

Information from the area of instructional program development and evaluation was obtained from interviews and questionnaires administered to CNTECHTRA (Code 016), CNET (Code N-9), and the IPDCs located at San Diego and Great Lakes. (Refer to Appendix A for names of specific individuals contacted at these organizations.) Individuals were asked to indicate the limitations of the CMI system and the steps that should be taken to improve the system, with particular concern for problems in the areas of CMI course design and development. They were asked specifically to indicate their perception of instructional requirements for ADP support of group-paced instruction.

One of the most frequently cited system limitations was that of the constraint on use of different types of questions for tests. Several comments were obtained regarding the need for constructed response questions for proper achievement testing. Although most respondents felt this was a serious limitation on the design of courses, it was not a universal perception. Another needed capability repeatedly mentioned was automated scoring of performance testing. The comments ranged from specific criticism about the current pass/don't pass provision for performance test scoring to one suggestion for scoring drawings of electronic circuits. As might be expected, the instructional developers did not discuss the cost factors associated with this form of test scoring, since their concern is with development rather than with cost accounting. Testing needs were also indicated by comments regarding the necessity for computer generation of tests from a pool of questions. Test security was cited as the major justification, although ease of test item revision and distribution of test materials would also benefit, if the test generation system were conducted on-line. Again, no mention was made of the costs associated with this capability.

Several individuals suggested the use of CAI for remediation purposes. This was mentioned in the context of having the system provide guidance to send a student to a microprocessor that would provide instruction on a particular set of objectives. This incorporation of CAI within the management role of CMI appears particularly appropriate given the proliferation of small computers within the training community. Proper administrative control over the CAI lessonware would be needed to assure the integrity of the test materials.

One suggestion provided by respondents was that CMI might be used to provide remediation for individuals in a group-paced course. This suggestion is worth pursuing if the costs for the CMI remediation would be compensated for through reduced student attrition. An implicit problem in this mixing of group-paced instruction and CMI is the mixing of mastery-based testing used in CMI with norm-referenced test procedures generally used in group-paced instruction.

Again, the need for a resource allocation system was mentioned frequently. In technical training schools where there is a limited amount of training devices, use of the training devices by individuals can create student-flow bottlenecks if the use of the devices is not optimized. The allocation and scheduling system would serve this purpose.

Although course coding was not mentioned as a serious problem, there were comments regarding the need to improve the communication interface between the course designers and the coders. There is a concern that centralizing coding at MIISA might exacerbate coding problems through further deterioration in the designer/coder interface.

The IPD personnel indicated that the CMI Item Analysis Report and the Module Performance Analysis Report are used with a fair degree of frequency in their course

validation efforts. Other CMI reports, such as the Student Learning Guides, Student Progress Reports, and the Response History Reports, are sometimes used for small-group tryouts of instructional materials. In regard to reports, a number of comments were made about the difficulty in obtaining special data requests. This delay in obtaining special data printouts is due to the requirement for MIISA to program each special data request.

In response to the question about required ADP support for group-paced instruction, several respondents indicated the general need for batch scoring of a group of test sheets in a short (15-20 minutes) time with the results provided back to the instructor as a listing of students and test scores. The most detailed description of guidelines for automated support for group-paced instruction, which was provided by CNTECHTRA Code 016 (Ms. Diane Kalivoda), has been distributed to other organizations and has been independently cited a few times as an indication of what is needed to support group-paced instruction. This document is provided for detailed study in Appendix D. An additional document that guided the task group team in their analysis of group-paced instruction support was Draft CNET Instruction 1540.2, subj: Testing and Management of Student Achievement.

To contrast the type of support needed for group-paced instruction as oppposed to individualized instruction, the following summary is presented:

> While test scoring for CMI is done on an individual student transaction basis, scoring for group-paced instruction should be done on a batch basis, with all students in a class having the same test scored at the same time. Instead of individual student learning guides being produced by the system, as is now the case for CMI, the computer should provide the instructor with a list of student names or SSNs, the test scores, an indication of whether each student passed or failed, and a listing of objectives failed for each student. The instructor could then either orally make a remedial study assignment to the class for particular objectives or post study assignments for the list of objectives, and the students could determine their own individual remediation requirement. In many of the larger courses, providing the feedback to the student may be even less of a concern. The primary concern is in making sure that the tests are scored rapidly and that the data are stored for subsequent analysis for management purposes. The development of the computer program and school administrative procedures that would permit 100 percent mastery testing/remediation on an individual student within a group-paced course--and still maintain class progress--remains to be done, although the desire for this capability is mentioned repeatedly. From the combined responses from IPD personnel, the task group derived some general requirements for group-paced ADP support. These are provided in the report section on Instructional Function Specifications.

Information Regarding Technological Opportunities for CMI

Information regarding technological opportunities for CMI was obtained from interviews and personal contacts with experts from Navy training and research organizations, other military and civilian agencies, and private corporations involved with computer-based instructional technology. For the purposes of this summary, the technological opportunities to be presented include those technologies that were judged to have a high probability of successful implementation into a large-scale, operational, computer-based

training system. However, because of the extensive number of available hardware components, each having a prescribed set of capabilities and electronic/mechanical requirements, no attempt was made to catalogue these devices.

This summary will include a description of the technology involved, its advantages and disadvantages, and examples of where the technology has previously been applied, even if only on an experimental basis.

On-line Testing

On-line testing is the administration and scoring of tests through the use of interactive computer terminals. The student perceives the test question, usually from a Cathode Ray Tube (CRT) display, and enters the answer by means of a keyboard, although light/sound pens and touch panels are used occasionally. On-line testing permits easy revision of questions, automated data entry, and test scoring. For a large centrally managed, nation-wide CMI system such as the Navy's, on-line testing offers (1) the potential benefit of uniformity of questions across the same course offered at multiple sites, (2) immediate system-wide implementation of revised questions, and (3) a wider range of question format types beyond simple multiple-choice and true-false. The disadvantages of on-line testing include (1) a greater equipment requirement, since a student would be tying up a terminal throughout each test administration, and (2) a greater requirement for computer memory, because the computer would now have to store the entire text for each question and all answer options. A detailed analysis of test requirements and equipment capabilities is necessary to weigh the increased equipment and computer costs against potential savings due to reduction of hard-copy test reproduction, mailing, and revision costs. The technology is readily available and has been used in numerous computer-assisted instruction (CAI) systems. Any cost effectiveness of a computer-based instruction (CBI) system is generally not attributed to the use of on-line testing. An additional benefit for certain applications of on-line testing is the use of adaptive testing procedures to reduce each individual test length. On-line adaptive testing is presently being implemented in the recruiting centers across the armed services. This application, however, is highly suitable for adaptive testing, in that very few tests are on the system (development of each adaptive test is extremely rigorous and time consuming), and each test is administered to extremely large numbers of testees. Development of adaptive tests for an operational CMI system that uses many tests in a variety of courses to assess student proficiency is not considered feasible. NTEC is presently developing a Programmable Aiding/testing Learning Module (PALM) that could provide on-line testing if software were developed. The PALM provides a video display and an audio capability. While intended primarily for CAI support, it could be integrated with a CMI system.

A related technology that permits better student data entry without the expense of interactive student terminals is another form of electronic test-answer input. CNET is presently pursuing this technology in a form that evolved from the Test Input Device that was described by Hamovitch (1980) and was economically justified by Swope and Morris (1980). Current plans for the prototype input device development are contained in a report published by the Naval Weapons Center (1981). This form of student test data entry will replace the paper answer sheets and the existing optical scanners now used in Navy CMI with an expected training cost avoidance of approximately $4.1 million over a 6-year period (Swope & Morris, 1980).

The development in recent years of a wide variety of data input devices and computer terminals such as the PALM device that can use on-line testing presents an equally wide variety of options for the CMI system. However, extreme caution must be

taken prior to equipment acquisition to ensure that system costs decrease with no reduction in training effectiveness, or that system costs increases are compensated for with equivalent improvements in training quality.

Constructed Response Testing

Constructed response testing involves the use of test questions that require the student to recall and produce an answer, as compared to only recognizing an answer, as in multiple-choice questions. Typical constructed response questions are short answer fill-in. Constructed response questions are certainly not a new technology for the world of instructional development. The technological problem has been how to implement this type of question effectively on a computer-based instructional system. Even now, most CAI programs use only multiple-choice or true-false questions. The implementation difficulty involves developing suitable scoring procedures to account for misspelling and correct answers using alternate words. Software development is extremely complex and specific to subject matter. Instructional development procedures call for recall type questions for some types of objectives, but the present CMI system prevents their use due to the system's limited question format capability. By using an electronic test-answer input device, either on- or off-line, and the appropriate scoring procedures and computer programming, the CMI system could employ this type of question. Lockhart, Sturges, Van Matre, and Zachai (1981), in a study of the effects of test item format on learning and knowledge retention, found that valid-constructed response questions resulted in greater 2-week retention of information than did multiple-choice tests. However, there was a cost of longer training time. There may be applications in certain courses where the greater amount of retention would be worth a limited increase in training time. Analysis of particular subject matter is necessary to reveal those content areas where this form of testing would be cost beneficial. It should be noted that use of constructed response testing, or other technology or equipment, may be appropriate on a limited basis for a CBI system and would not require total system implementation. The CBI system would have to be designed from the outset to accommodate these additional capabilities even on a limited basis in order not to interfere with overall system operation. That is not to say that on-line testing, or even CAI, could not be done effectively away from the CMI system, with input to CMI being manually performed through administrative transactions.

Computer Aided Authoring

Computer-aided authoring is simply the use of the computer to facilitate instructional material text authoring and editing. This "authoring" does not refer to course coding, which could also be conducted on an on-line basis. The text authoring technology combines interactive computer terminals with special computer software permitting on-line generation of textual material. This type of authoring system, if combined with an instructional computer system, allows for the immediate transmission of materials from an authoring site to an instruction site. Course text material could be revised with equal ease. With IPDCs located in different geographic locations, an on-line authoring system would facilitate CMI course materials development and validation at other training sites. The authoring systems can also stand alone since they don't have to have a shared data base. A more feasible use with operational CMI would utilize the authoring system to generate on-line testing capability, with authoring limited to test questions and answer options.

A notable example of an authoring system developed within the Navy community is the system described by Braby and Kincaid (1981). A form of on-line authoring system for coding a CMI course should be developed to permit automatic debugging of course codes, prior to use by students. Having the coding performed centrally at MIISA would improve coding accuracy.

The primary disadvantage of a computer-supported authoring system is the computer system expense. This cost should be compared with potential savings expected from improved authoring efficiency and materials validation and production. For course coding at the MIISA site alone, the computer expense would be considerably less and probably well worth the addition of that capability.

The computerized instructional materials authoring system, as with the other technological developments discussed, represents reasonable opportunities for applying state-of-the-art instructional and hardware technologies, but these do come with a relatively high initial cost. They are not yet feasible for system-wide implementation. However, should the decision be made to upgrade the CMI system by means of a major system redesign, then in-depth consideration should be given to implementation of these technologies. It may be that the full benefit of these technologies may not accrue to the training community until a major CBI development effort is conducted, as is now being contemplated for the Defense Department for the next decade.

INSTRUCTIONAL FUNCTION SPECIFICATIONS

This section summarizes the requirements for the current CMI system, for ADP supported group-paced instruction, and for a CMI system with expanded capabilities. The required instructional functions were derived by analysis of the survey information regarding deficiencies in the existing system and desired capabilities for CMI and non-CMI courses.

While current CMI users express a major need for operational improvement, they do not express any significant need for change in instructional functions. Accordingly, no change in required CMI system functions is proposed. The interested reader can see a detailed function description for the existing CMI system in Section 1 of CMI User Manual 0, Guidelines for the Use of the Navy Computer Managed Instruction System.

The task group did develop CMI system operational standards that should be applied to any upgrading of the current system. These standards are contained in the following list.

1. To ensure proper school functioning, the CMI system should provide, at the school level, the functions of test scoring and return of test results with 95 percent reliability, even when the MIISA host computer is down. The function of providing prescriptive remedial study assignments should also be included, if possible, within resource constraints.

2. The RT, from insert of answers to receipt at the printer of a typical 20-line student learning guide, should be no longer than 30 seconds. Learning guides may be a maximum length of 40 lines and have a maximum associated RT of 40 seconds.

The task group believes that if the current CMI system were modified to meet the preceding standards, the major system problems of RT and DT would be eliminated.

Because of the extensive administrative and testing requirement for non-CMI schools, it is necessary to develop the instructional function specifications for an ADP system that would support group-paced instruction. In addition, the technological advances are such that any review of CMI functions should provide function specifications to derive system upgrade alternatives that would provide support for group-paced instruction and expanded CMI capabilities. To provide a structure for describing function specifications, an outline

was developed that lists all of the general functions carried out by any training system, irrespective of how, or to what extent, they are accomplished. The function outline is presented below, and descriptions of activities conducted in the function are contained in Appendix E. Two examples of outlines used as aids in developing the present one were provided by Lintz, Tate, Pflasterer, Nix, Klem, and Cuick (1979) and Micheli, Morris, and Swope (1980).

1. Instructional Delivery

2. Instructional Management

   Student registration
   Training path selection
   Student/instructor data input
   Test scoring/feedback
   Remediation/prescription
   Student progress tracking
   Management information reporting

3. Instructional Support

   Instructional program development
   Training program validation
   Resource allocation
   Instructional system security
   Historical record keeping

This outline organizes the following descriptions of function specifications for ADP supported group instruction and for an expanded CMI system.

ADP Supported Group-paced (ADP-GP) Instructional Function Specifications

Group-paced instruction in Navy technical training is conducted in multiple schools located at numerous bases across the country. Each school may have classes in more than one building. Classes may vary in size from less than 20 to more than 500. Also, the method of instruction within a class may vary ranging from group-paced, through group-assisted self-paced, to fully individualized for portions of the course. The courses will vary from mostly knowledge-oriented to mostly performance-oriented courses. As a result, the ADP-GP system must be flexible enough to accommodate extremely variable instructional requirements. The function specifications provided here handle this flexibility by estiablishing upper limits to cover the majority of the cases but still will not be prohibitively expensive. For each general function, the ADP-GP function specification involving the learning environment is presented. The specification is then followed by a section regarding computer implications. The comments in the computer implication paragraphs should be viewed as reasoned suggestions but not precise design requirements. Computer design suggestions are based on the precept that processing should be kept as close to the user as possible to minimize RT and DT problems. Naturally, a detailed systems analysis is necessary to specify exactly where in the computer system a particular process should occur. Thus, these comments should be considered only as suggestions to facilitate costing of preliminary system upgrade alternatives.

Student Registration

Specification. Students should be registered onto the system at the school site into a designated course. There should be provisions for entering normal student data, including

identifying information, demographic data, and aptitude test scores, as well as nonroutine information, such as student's participation in a special program (e.g., Job Oriented Basic Skills (JOBS)). It should be possible to register students either individually or in groups throughout the training day or after normal school hours. The student should be able to begin training during the same day of registration. Friday evening registration should be possible to permit a Monday training start.

Computer implication. Since much of the student data may already be in this or other systems, the ADP-GP system should be capable of completing or verifying student registration by interfacing with other available information systems. It should also be possible to change student data incorrectly entered. Data on active students should be maintained on a computer at the geographic site, with records established at a centrally connected mainframe.

Training Path Selection

Specification. This function will assign students to one of several different course patterns that define different curricula within a single course. (These patterns may be designed to accommodate differences in branch of service, rating, or prospective assignment.) The system should be able to assign a student to more than one instructional module at a time. The instructor should be able to override a pattern, module, or lesson assignment, assuming appropriate administrative approval. The instructor should be able to assign a student to night study.

Computer Implication. Since most group-paced courses are not divided into instructional modules, as in individualized instruction, this function, at the module level, would not be expected to be very active. However, the capability should exist for those courses desiring it, and definitely should include the capability of assigning students to night study.

Student Data Input

Specification. Student data (responses to test questions) should typically be entered through paper machine-scorable answer sheets. Students would use pencils to mark the desired responses to the multiple-choice questions. Electronic test-answer input devices could efficiently be used for student data entry, if the school organized their testing schedule so all classes would not be taking tests at the same time. If class tests were staggered, a class of 25 students could use the devices and take their tests, have those data entered into the instructor terminal, and then pass the devices on to the next class of students for their use. This staggering would permit the greatest student/test-device ratio possible, thereby minimizing training equipment costs.

Computer Implication. Peripheral equipment at the instructor level should permit entry of data on paper answer sheets. In some locations, this would require a high-speed reader such as a Scantron, and an optical link to match up with the student electronic test-answer input devices. Not all schools or classrooms would have to have both entry methods.

Instructor Data Input

Function. Instructor data would typically be entered through the microterminal at the classroom or school level. Appropriate codes should be available, so that the instructor could enter administrative instructions via answer sheets or through the electronic test-answer input devices. This permits the instructor to enter information or query the system without requiring the instructor's presence at the terminal.

Computer Implication. No major implication other than the cautionary note that codes should be established for certain specified administrative transactions, as is now possible with the existing CMI system.

Test Scoring/Feedback

Specification. The system should permit the scoring of large numbers of tests at essentially the same time. At the classroom level, the instructor should be able to ask for the scoring of a particular test, enter as many as 100 answer sheets for that test and within 15 minutes, receive a hard copy listing of classroom I.D., date, an alphabetical or SSN list of students (choice of school), each student's total test score (number of items correct), an indication of failed objectives for each student, and average class score. Tests would consist of up to 100 multiple-choice items with each item coded to specific learning objectives. Test scoring for classes with more than 100 students would be permitted to take longer, although no slower than 300 tests scored and data returned per hour. Each classroom would not be expected to have its own test scoring system but, at least, each building containing active classes would have the scoring capability. At the school's option, study/test time could be entered on a class basis for each test.

If the computer located at the geographic site was not operating but the instructor terminal was operating, there should be a provision for the instructor to physically get a scoring key from a secure location, enter the scoring key, and then enter student answer sheets. This process would only provide the instructor with the number of items correct and average class score, but it would permit continuation of instruction as a back-up for those times when the geographically-located computer was down. At the classroom, this function should be available 98 percent of the time. After the computer was back up, the answer sheets would again be entered to make sure data got into the system.

Computer Implication. At each school building site, there needs to be at least one microterminal that would be operated by a Navy instructor. Peripheral equipment should permit high-speed acceptance of machine-scorable answer sheets (such as a Scantron) and provide hard copy printout. Instructor sign-on would call up the appropriate test-answer key and objectives list for scoring at the local Mainframe or minicomputer. The scoring key would include a pass/fail criterion for each objective. Student responses and test results would be processed and stored in the Mini, with reports sent back to the instructor. Test results would then be sent to the central Mainframe. Response histories would be maintained at the Mini while students are active. Class files should be retrievable either in alphabetical or SSN lists. As students complete the course, data would be stored on tape at the Mini for use during course validation. The Mini would have to be structured to handle multiple requests for test-answer files, since several schools or classrooms might submit scoring key requests at the same time. Files would be needed to store class study/test times, if those data were entered.

Remediation/ Prescription

Specification. The system should provide remediation and a study prescription if possible; at the minimum, it should provide the instructor with an indication of the objectives failed by each student. The instructor could then make his own remedial study assignment, either orally or by posting an assignment list for each objective. Typically, the instructor would check his summary test result listing and then critique the test for the class as a whole. Instructors could assign remedial tests as desired, although these tests might be submitted at night study. The class listing of failed objectives would enable the instructor to emphasize in a lecture those objectives failed by a large number of students.

Computer Implication. The system should make a determination of remedial assignment or study prescription. The system would match student answers against the scoring key and print out failed objectives as a minimum feedback. System structure should permit tests to be scored and data to be entered for an individual student but on an exception basis. Immediate response for a single student test entry would not be expected.

Student Progress Tracking

Specification. Progress tracking in group-paced courses is largely a matter of knowing how many days the student has been in a course, test scores, objectives passed/failed, amount of setback or advance time, and time for course completion. It should be possible for the instructor to query the system to determine the student's course progress in terms of number of days in course, days to course completion, number of setback/advances and their duration, objectives passed/failed, and test scores. The instructor should also be able to obtain information regarding study or test time in hours, on a class basis, if it has been entered. This information should be available on a class basis in alphabetic or SSN listing or for individual students. Response time should be within 10 minutes throughout the day.

Computer Implication. Instructor queries would be made at the classroom level. Data should be retrievable for a class of students or individually. Response time should be within 10 minutes throughout the day. Study/test time (hours) for modules/tests would be available only if entered for the entire class by the instructor.

Management Information Reporting

Specification. Information reporting in the training environment involves providing data to the student, instructor, school, management, and course developers. In the group-paced system, the student would get his information from the instructor. The instructor should be able to obtain data as a result of an administrative query at the classroom terminal. The instructor reports, available on a class or individual student basis, should include the following information: course pattern status matrix (sequence of modules), scores on specified tests, objectives passed/failed, missed tests for authorized/unauthorized reasons, number of setbacks or advances, number of assignments to night study, class standing on a test or for the course, and days to graduation. The data elements should be available at the instructor's option.

At the school level, the same information should be available as a result of an administrative query for separate classes or for the entire school. The data should be requested by category (e.g., setback or advance report, class standings (average scores for students in a class, average scores for a class on a specified test, or cumulative average score for each student), students assigned to night study, students in specified course patterns). Additional school reports should be available regarding equipment or instructor scheduling. All of these reports should be available to the Curriculum and Instructional Standards Office.

At a higher management level, data should be available summarized for classes at each school or summarized for several schools. Management reports should be provided during off hours with no immediate response required.

Course developers should have available not only summarized data for individual students and for classes of students, but also data regarding student responses to particular tests or test items, test/study time, for course validation purposes. Course

developer data would not be obtained from a terminal in a school, but from a terminal at the course development office. Because response time is not critical for the course developer, their data requests would be met on a batch job basis, since tape files might have to be searched.

Computer Implication. Given the data summarizing requirements of the system, a greater amount of file storage must exist at the local site level than is presently available. The implication of this is that more software will reside at this level. Administrative procedures should be established that would allow software modifications only at the Mainframe level to be transferred to the Mini. For the management requests, data summaries might be developed at each site and then passed as a unit to the Mainframe. Since the historical records for all students completing a course are kept at the Mainframe, only a search of active files at the local sites would be necessary to provide a comprehensive system data summary. A fundamental implication of the data requirements is that there would have to be a data base management capability of greater flexibility than exists in the present CMI system.

Instructional Program Development

Specification. Instructional program development includes both course authoring and validation. For this system, there should be an on-line course authoring (coding) capability to develop and debug course files. This form of authoring does not include authoring of instructional text or even test questions, but only the computer coding of the course. Centralized coding may be the optimal approach for this function. The school should have the capability to request changes to course coding, assuming appropriate administrative approval. Active course file code changes should typically be performed during nontraining hours. Some consideration could be given to providing IPDCs with an on-line authoring system, independent of the ADP-GP system, if resources were available.

Instructional program validation involves that evaluation necessary to assess the quality of the instruction. Course developers should be able to extract information regarding student answers to specific test questions, summary scores for objectives/tests, or courses. A program should be available to assess student attitudes toward the course and school. Item analysis and the student performance summary reports should be available to developers but would not require immediate availability.

Computer Implication. On-line course coding at certain sites would have to be accommodated at the local level and should include certain debugging procedures to ensure that adequate testing of course codes takes place. Another option would be to have a centralized coding capability. On-line text authoring on independent computer systems would have no effect whatsoever on the ADP-GP system. An attitude assessment program would only involve coding of another test that had assessment items as questions. Review of the attitude assessment would be done through an item analysis program.

Training Program Validation

Specification. Training program validation focuses on assessing the overall course effectiveness as opposed to determining module objectives or test validity. This means an overall concern with how well the course is meeting training objectives, in terms of fleet performance and cost effectiveness. For overall system evaluation, schools will be entering into the system as part of the resource scheduling function, the data about the numbers of students, instructors, and equipment purchases. The school should then be able to request a report providing information about overall operation costs, course development costs, training costs per student day, etc. These system evaluation reports would not be available immediately, but should be available within one work week.

Computer Implication. While much of the required information is already on computer systems, it will be necessary to build group file structures and programs that can acquire, store, and process this information. Again this will require a sophisticated data management capability. School data would be kept at the Mini, while the overall system data would be stored only at the Mainframe but would be accessible at the school level, assuming administrative approval for the request.

Resource Allocation

Specification. Resource allocation in a group-paced course should involve the scheduling of students, instructors, and equipment. For the ADP-GP system, the primary accounting requirement would involve equipment inventory listings. For a few courses using a limited number of training devices, a scheduling system should be available for determining which students have or have not used the device. A report should be available to the instructor regarding who has or has not completed training with the device.

Computer Implication. The resource allocation system files would need to be maintained at the Mini level, but searchable from the classroom. Certain reports regarding usage of very limited equipment could be automatically generated on a specified basis (e.g., daily).

Instructional System Security

Specification. Integrity of the school tests is crucial and is maintained primarily by using the computer for scoring. Since a backup method for test scoring involves having hardcopy scoring keys, these keys must be kept in a secure location at the school. Additional test security should be provided by having the order of response alternatives for multiple-choice questions altered for different administrations of the test. For any one class of students taking a test, however, the same scoring key would be used, so the instructor might need to observe students during testing to prevent students from cheating. Instructor codes would have to be used to ensure that only instructors enter information into the system. This part of the system could be secured by making the microterminal off limits to the students. Computer ID/Password codes should be used to make sure that unauthorized use of the computer for non-school purposes does not occur.

Computer Implication. Computer security schemes have to be established to limit access only to authorized individuals. A system for altering the sequence of response options would have to be developed. This could be done at either the Micro or Mini levels of the system. A computer monitoring system should be developed to examine the kind of usage occurring at each Micro to determine whether it is being used properly.

Historical Record Keeping

Specification. Historical records should be kept readily available on the total system for at least 2 years and stored archivally thereafter. Data available on a quick-response basis would be limited only to active registered students. Data on students graduated or attrited from the school would only be available through an administrative request honored on a batch, time-available basis.

Computer Implication. The historical records for students should be kept on the Mainframe for 2 years. They should be stored in summary fashion that would still permit comparison of course objective data with fleet performance data for an individual student for system evaluation. Other data regarding the effectiveness of the system (training

development, equipment, and instructor costs) should also be summarized and stored at the Mainframe site for system evaluation purposes. With the greater number of students on the system (over 10,000 AOBs estimated), sizable facilities for data storage are necessary. An elaborate data management capability is probably necessary to make these data available on a timely basis.

Expanded CMI Instructional Function Specification

If analysis shows that a redesign effort is necessary to fully resolve the RT and DT problems, then the redesign might profit from the addition of capabilities not presently on the CMI system. The expanded CMI system, then, is comprised of functions now satisfied by the existing system, plus those functions expressed as desirable by operational users or that would benefit the training communities, as indicated by research or application data. The specifications provided in this report will focus on those additional functions that will "expand" the range of system capabilities for CMI. Since some of these functions have yet to be demonstrated as being truly cost effective, their actual implementation on a system-wide basis should await those cost data. However, if the functions are ever to be implemented, they must be considered in any initial redesign analysis so proper file structures, memory, and software can be provided. It is feasible that a particular function could be developed in the central computer (by dedicating file structures) but not fully programmed. If resources were available in the future, the programs could then be built on a test basis. If small-scale tests showed the function profitable, the function could be implemented system-wide. This development approach would avoid purchasing equipment that would not be used operationally. Since some of these functions are little more than concepts, it has not been possible to provide a detailed specification. Accordingly, the resulting estimates of costs for the expanded CMI system should only be viewed as rough approximations. Management can at least have an order of magnitude esimate about the cost of the designated expansion.

The expanded CMI system can be envisioned, at the schoolhouse, as the current CMI system with expanded methods for data entry (including optical scanners, electronic test input devices, and microterminals), greater flexibility for data manipulation, and greater capabilities for course and system evaluation. A key design precept to make the expanded system operate with the minimum DT and fast RT is to keep computer processing as close to the user as possible. While the present system design does not specify all processing at the terminal level, there is an obvious need for a greater amount of test evaluation at the local site level, along with an increased need for processing and storage at the central site. One could expect the expanded system to be more costly to design, develop, and implement than a redesigned system providing only the current CMI functions. A key question, however, is the extent to which the costs of developing an expanded system are greater than those of developing a redesign of the current system. If the expanded system is not significantly more costly than that of a redesigned current CMI system, then its development might be warranted. A thorough systems and economic analyses would be required to answer the question definitively. Figure 1 is provided as a pictorial representation of the expanded CMI system to be described in the following pages.

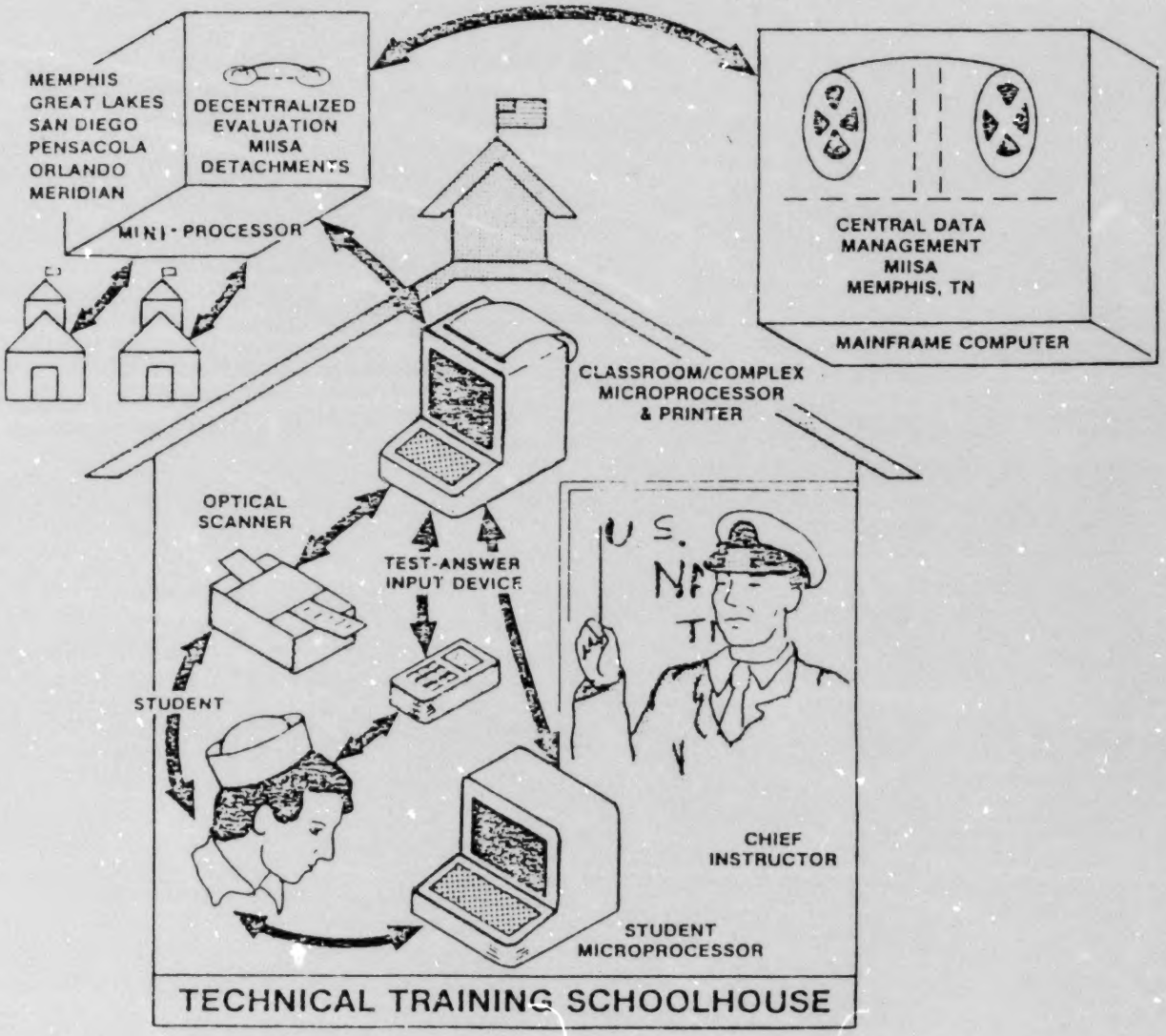

Figure 1. Pictorial representation of expanded CMI system.

Instructional Delivery

Specification. CMI is defined as a system in which instructional delivery occurs off-line the computer system. In an expanded CMI system, however, there should be the capability to deliver adjunct instruction through connected microprocessors. These processors would be connected to the CMI system to share summary data but all instructional delivery would occur via software on the microprocessor. This instruction

amounts to CAI and would be very limited in scope. Generally, it would be provided only in a few courses and only for those course objectives that require the dynamic processing capability of a computer. An example of such a learning objective suitable for this type of instruction is one that involves understanding the process of variational analysis of current flow in a complex electronic circuit. Without detailed knowledge of course objectives requiring this type of instruction, it is not possible to provide an accurate system "specification." What is necessary for the expanded CMI system is the provision for the interface between the expanded system and the adjunct microprocessor.

Computer Implication. An interface would be necessary between the system computer and the microprocessor. Since there would be a variety of subject matter in different courses, there should be a standard interface specification to permit this capability to be implemented as the requirement is identified and materials are developed. File space in the expanded system would probably not be large enough for storing summary performance data for individual students.

Student Registration

Specification. For the expanded system, student registration will be very similar to the current system. It should be designed so that a student can register at any time and immediately begin interacting with the instructional system. Additionally, there should be a simple procedure for transferring registration information on a student from one course to another. There should be a provision for storing nonroutine information (e.g., student's participation in a special program such as JOBS) and an automatic program for prioritizing student entries into a course, if there is a backlog. These functional additions are of a modest nature and would be extremely easy to develop and low in cost, if done during a major software redesign effort. They might have significant payoff by improving student flow through the training pipeline.

Computer Implication. The registration functions would be easy to incorporate during a redesign effort and would not significantly add to the processing requirement.

Training Path Selection

Specification. The major addition for this function involves the capability for reassigning students to scarce training resources. The system would have to monitor student assignment to modules and interact with the resource allocation system described later to determine availability of the limited resource (e.g., training device or lab station) and make the appropriate assignment. A second addition for training path selection function is the assignment of students to a major segment of basic skill training (e.g., JOBS Program). This function would require accessing basic skill diagnostic information and making the assignments as space becomes available. The system should also be able to assign more than one module to a student, although there should be a prioritization given along with any multiple study assignments.

Two other variables that should be used in making differential training path assignments are aptitude and previous performance data. Although easy to implement on the system, research should be conducted to justify the effectiveness of the differential assignment procedure. Although some research literature indicates that aptitude levels do have a differential effect on learning, depending upon the instructional treatment, operational application should be attempted to determine the practical value to Navy CMI. Since a training path could be varied for several reasons, a special form of "lost time" should be created so that time away from a typical course pattern would be properly accounted for.

Computer Implication. Expansion of the training path selection process would not require significant additional computer processing, although, as defined, a resource allocation system would have to be programmed and it must interact with training path selection. In view of the anticipated improvements in student flow and training equipment usage, this functional addition could be very cost beneficial. Benefits from the differential assignment to course material, as a function of aptitudes or previous performance, should be verified through research before system-wide implementation. Since the function would not be costly to develop during a redesign effort, it could be built and tried out on an experimental basis in isolated learning complexes to obtain justifying data.

Student Data Input

Specification. The system should permit the student to enter data into the system by any of the following means: machine-scorable answer sheets, portable electronic test-answer input devices, electronic keyboards on microprocessors, or automated performance test devices. Ideally, input data could be either numerical or alphabetic in nature, or a response defined by a skill performance task (e.g., teletyping skill). It is not necessary to provide all the data entry mechanisms for each learning complex but, rather, only those data input methods that are needed. Given the state of the art, application of the electronic test-answer input device should clearly be implemented on a wide-scale basis and keyboard equipped processors should be installed for those courses with a sizable requirement for either constructed response testing or for performance tests that could be simulated in a two-dimensional device.

Computer Implication. Since costs for all of these input devices could be prohibitive, appropriate justification should be provided to school implementation. Developing a standard interface specification for the automated performance tests (APT) would be highly desirable, since APT implementation to date has been on a case-by-case basis (e.g., TIMES for the RM school and NEWTS for the EW school; in both of these cases, interfacing has been problematic). If the interface were properly developed and only summary data submitted to the central Mainframe, there would not be a significant effect on the central system.

Instructor Data Input

Specification. Instructors should be able to enter data by the same means available to the students. It should be expected that there would be instructor terminals available for making specialized data requests.

Computer Implication. Permitting instructors to enter data on the same devices as the students requires only proper coding. If the instructor is making variable data requests, the system must have a flexible data base to satisfy the requests in a short time (a few minutes). Having an easily accessible data base absolutely requires redesign of the current system and will probably be expensive.

Test Scoring/Feedback

Specification. Test scoring should be expanded to include scoring of constructed response (fill-in) type questions. Data exist that document the increase in information retention by use of valid fill-in questions. Proper analysis should be done to document those cases where fill-in questions are necessary and could profitably be implemented. The ISD procedure does require constructed response testing for certain kinds of objectives. A fill-in test item procedure, using only a limited string of characters (no

more than 20) and an inexpensive electronic test-answer input device, might be developed and implemented cost effectively. Other scoring procedures that should be available include the scoring of automated performance tests. The computer system should be designed so that the APTs are scored as close to the test situation as possible to minimize costly transmission of response data and resulting RT and DT problems. One application of fill-in testing would involve on-line testing (computer-generated tests) where the student receives the test questions directly from the computer. This would require more student terminals, since a student uses the terminal for the entire duration of the test. Again, this function would have only a limited application.

Computer Implication. Scoring of alphabetic fill-in items requires relatively sophisticated programming to accommodate misspellings and alternately spelled words that are actually correct. The programming would have to be developed. If the testing and scoring procedures were conducted on a microprocessor and only summary data submitted to the central system, there would be no negative effect on the overall system and scoring errors and effects of system RT and DT problems would be minimized. Careful analysis should be performed to ensure that use of these procedures will be cost effective and not merely satisfying an ISD requirement. A major issue in scoring involves deciding where the actual response data should go for scoring. Should it stay at the input device or should it go all the way to the central Mainframe? There are pros and cons for both approaches. The use of on-line testing or computer-generated testing would not affect the Mainframe if the tests were done on adjunct microprocessors, but it certainly would increase central processing requirements if the Mainframe were expected to handle that capability. Not only would the computer be tied up during testing, but the course files would have to be expanded to include the actual test question text and all the appropriate response options. Again, this function could be considered in the redesign and structured as a researchable area, implementing the capability only after justifying data are available.

Remediation/Prescription

Specification. Expansion of this function includes providing the capability to differentially assign alternative versions of training material for within module remediation purposes, depending on aptitude or prior performance data. This function has a low priority for implementation, and cost data are needed to determine whether it contributes to training effectiveness or not.

Computer Implication. Providing the capability to assign different materials would be quite easy and cheap from a computer perspective. The high cost area, however, would be that of developing alternate media forms for the same learning objective.

Student Progress Tracking

Specification. Student progress tracking should be expanded to provide the instructor with up-to-the-minute data regarding student performance, as opposed to data current to the preceding day. These data could be used with the incentive charts, developed by NAVPERSRANDCEN for students and instructors, to improve student flow through an individualized course. Additionally, the data could be used in Academic Review Boards or in conjunction with a flagging system that would alert an instructor to a student who had seriously exceeded predicted study time.

Computer Implication. Providing up-to-the-minute student progress data is not possible with the present system without restructuring the data file system. It would be easy and cheap to provide this function, if a redesign effort were performed.

Management Information Reporting

Specification. The focus for this function is to improve the retrievability of stored data for all users within the training system. Up to the minute data for active students should be available to the instructor or school on a quick-response basis (within 10 minutes). Student performance summaries should be developed that are concise and easily available. Summaries for historical data should be available within a few days without special programming. It should be possible to obtain group data for CMI system students categorized by demographic or aptitude variables. Management should be able to obtain summary reports on the cost effectiveness of individual schools or the expanded CMI system as a whole.

Computer Implication. Improvement of data retrievability will require a redesign effort. To have some of the desired information available at the school level on a rapid-response basis may well require storing of the information on a computer at the geographic site. Providing management reports with system evaluation information will require adding data elements to the system but is quite feasible during a redesign effort.

Instructional Program Development

Specification. Improvement of the instructional development function involves both authoring and course validation. An ability to diagnose course coding (authoring) problems should be developed on the system as the minimum addition. With the expanded system, course coding should be performed on-line, with a series of instructions provided to the coder, to ensure that the coding process is performed efficiently and accurately. In terms of authoring instructional text, the expanded system might have the provision for IPDCs to perform text authoring, at least within their organization. Practically, it would not be possible to implement full ISD authoring throughout the expanded system, given the constraints of limited time and resources. As an initial phase of development, however, a portion of the computer system should be made available for limited course authoring, to develop the kinds of procedures that would surely be implemented in a newly developed CBI system. This very limited authoring capability could be part of a research effort conducted in a limited context (e.g., in one school).

Course validation should be expanded by making performance data more readily available to course developers and developing a student assessment procedure. Students would respond to an attitude questionnaire and enter their responses into the system as they normally do. Of greater importance is the provision for improved course material validation by mapping fleet performance data with learning objectives through objective-coded test items. This would improve the ability to identify deficient materials that had a negative effect out in the fleet.

Computer Implication. The establishment of any on-line system, be it coding, text authoring, or student testing, will have a significant effect on the computer system, particularly if the function is implemented system-wide. The effect would include a greater requirement for computer processing, which might be offset by improved course operation due to better course coding. The text authoring would be particularly costly but, if implemented, it would permit course designers to develop materials (tests) and immediately send them out for tryout. If successful, the tests could be used immediately with no delay or additional expense for materials reproduction, mailing, or insertion. As desirable as this function may seem for course developers, it could be very costly to computer operation. Implementing both the authoring and validation capabilities in an R&D complex of a limited scope would permit obtaining justifying information with little cost and low possibility for major system defect. This functional capability should be

included in any initial redesign requirement on a limited basis to make sure that it would be possible to implement it system-wide in the future.

Training Program Validation

Specification. This added function should permit the determination of the extent to which the course is meeting fleet objectives by relating fleet performance data back to test items and learning objectives. Additionally, this function would permit the assessment of overall system effectiveness by integrating training and performance data with operational training costs and instructional development costs. Much of this information is already in existing data systems and it would simply have to be brought together and integrated using appropriate models. This component would also assist in determining the relationship between achievement across courses or components of courses.

Computer Implication. This function involves the integration of existing file structures with new data elements not presently on the system. If a redesign effort were conducted, the necessary files and software could be provided, with relatively small cost in processing time. The processing to integrate the desired information could not be easily done on-line and requests would take time to satisfy. If files were set and the program in place, it would then be possible to develop and obtain a standard report with no special programming, other than entering certain parameter values such as the time period, schools, or students involved. At present, no resources are available to develop this function.

Resource Allocation

Specification. A resource allocation system that would schedule students, instructors, and equipment is required for the expanded system. This allocation system should permit students to be called to use a limited resource such as a training device and then sent back to the normal course sequence. This system could improve student flow and would make better use of equipment. A standard equipment inventory report should also be available. It should monitor the availability of school supplies/equipment and provide flagging functions at appropriate times to personnel responsible for procurement and maintenance.

Computer Implications. The resource allocation system adds an additional accounting task to the computer but it should present no problem if constructed during a system redesign. It would be necessary for this system to interact with the training path selection system to ensure an orderly and controlled flow of students. Some additional information reports could be provided to inform school personnel about equipment and supply availability.

Instructional System Security

Specification. A security function is required to maintain the integrity of tests, student data, and use of the computer. With more functions handled by the computer system on the expanded CMI system, security would be maintained through tighter application of computer codes and instructions. A monitoring system should be built into the computer to identify improper use of the system. This function is like that described for the ADP-GP system.

Computer Implication. The addition of codes and computer instructions should add no great load on the computer. Having the computer scramble test item response alternatives increases processing slightly; however, if the items are already on the system, in the

form of on-line testing, there would be no increase in computer requirement. With more of the school's tests on the computer, there should be at least a perception of greater test security.

Historical Record Keeping

Specification. As with the ADP-GP system, the expanded CMI system should have improved record keeping capabilities with the data stored at the central site, except for active students. Data for active students should be retrievable from the geographic location. The historical data would be accessed through the management information reporting function.

Computer Implication. The major implication for the computer is the requirement for greater storage at the Mainframe and an improved data management capability (random access to files) to service the increased number of types of requests. It would not be expected that the historical data could be accessed immediately. Responses to requests would require several days to be satisfied but should not require special programming.

CMI SYSTEM UPGRADE ALTERNATIVES AND ESTIMATED COSTS

The alternatives for CNET to consider for upgrading the CMI system evolved in part from the analysis of user need information. The alternatives include the following:

1. Perform minimum system modification that will provide, at least temporarily, an immediate resolution to the RT and DT problems.

2. Perform the necessary analysis and, if warranted, redesign the CMI system to provide only the current set of required CMI functions.

3. Perform the analysis and redesign to combine required CMI functions with the desired set of functions for ADP supported group-paced instruction.

4. Perform the analysis and redesign the system to provide expanded CMI capabilities combined with ADP support for group-paced instruction.

An additional option for CNET, although not directly involving the CMI system, is to develop and acquire independent ADP systems for supporting group-paced instruction. This report section will discuss each of the CMI upgrade alternatives and present preliminary cost estimates. The cost estimates developed by MITSA should only be viewed as rough approximations. Only after more extensive analysis and refinement of system specifications can accurate costs be determined.

Alternative 1--Immediate Resolution of RT and DT Problems

Resolution of RT and DT problems through application of rapid management actions will improve system operation, at least on the short-term basis, and is necessary to minimize current student backlog conditions. This approach will provide continuation of existing required CMI functions. Many of the actions that are possible have already been implemented during the past 2 months and there has been significant improvement in computer RT. To obtain this short-term RT improvement, however, it has been necessary to alter some of the computer subsystems and to modify some school administrative practices. While the changes in school administrative practices are endurable over the

short run, a more permanent fix needs to be developed. MIISA has already completed the following actions:

1. Files have been split to isolate major files used by EVAL or to separate disk drives.

2. The RSCAN program has been revised to minimize and isolate effects of long learning guides.

3. Errors in equipment operation have been corrected.

The total effect of these changes has been to improve RT, but they have not pinpointed the source of the problem. Consequently, improved system operation may once again deteriorate as soon as additional student load or more courses are added to the system. In fact, the addition of processing requirements onto the computer for some of its non-CMI data systems may bring back the long RTs that are so frustrating to student and instructor alike. The system is saturated.

Certainly MIISA should and will continue its efforts to isolate the factor or factors that are responsible for degraded system performance. For example, MIISA is revising the registration program to increase system efficiency. It has been necessary to add a minimal amount of personnel and equipment resources to provide these changes. The estimated cost for the purchase of equipment is $33,000 and there is an increase of $330 on monthly maintenance. A one-time cost for developmental labor is $21,000, direct salary only.

Alternative 2--Redesign System to Provide Only Required CMI Functions

If analysis reveals that a redesign is necessary to permanently resolve RT and DT problems, this upgrade alternative will result in a system that would provide only the current set of required CMI functions and would be expected to be the lowest cost redesign effort possible. The redesign would probably require additional personnel and equipment at either the MIISA Memphis or the MIISA detachments. A major design decision that would drastically vary the application of personnel and equipment is whether the evaluation component of the computer system should continue to reside in the Memphis Mainframe or should be distributed to the computer at the local sites. It needs to be emphasized that merely distributing evaluation to the geographic site does not guarantee improved RT and DT. While that step would reduce problems associated with long-distance line transmission errors, it may only serve to distribute the RT and DT problems. Only by performing detailed analysis to pinpoint the exact source or sources of system problems can they accurately be identified. Once identified, a decision can be made on how to correct the problem. Since the source of the problem is not known at this time, and since system redesign could involve either adding to the Mainframe capability or distributing evaluation processing to the geographic sites level, it is appropriate to estimate what the redesign and implementation costs would be for both alternatives. Accordingly, there will be two Alternative 2 design estimates: (1) Alternative 2A--Redesign to provide required CMI functions by adding to central site, and (2) Alternative 2B--Redesign to provide required CMI functions by distributing processing to the geographic sites (detachments).

Alternative 2A--Required CMI by Upgrading Central Site

This alternative provides for an enduring fix of RT and DT problems. Implementation would be accomplished by adding to the central site processing capabilities and would

require 1-2 years. Many of the system changes are directed at improving the entire facility and not just improving CMI operation, since the two can't be isolated. The cost estimates, which are provided in Table 2 assume use of current Honeywell equipment and are broken into two categories: (1) items unique to fixing the existing centralized system, and (2) items desirable for any system.

Only the $164,000 cost for items unique to upgrading the centralized system should be used in alternative comparison. The $863,000 for desired additions is an expense that could be applied to all alternatives should a redesign effort be necessary. What is not included at all is cost for a second Mainframe to use as a development computer, should that be desired.

Alternative 2B--Required CMI by Distributing Processing

This alternative also ensures an upgrading of the required CMI system operation. However, the solution is achieved by distributing the EVAL program processing to the local geographic sites. This alternative assumes the use of Honeywell equipment that would be procurred in about 1 year. Further, it assumes the need for a Honeywell 6620 processor at each site, since MIISA believed that the Level 6 minicomputers would not have the ability to support the EVAL program and that a dual system, similiar to that in the present system, would be needed at each site, along with an uninterruptible power supply. This approach recognizes the high cost for each site; hence, it is assumed that only NTCs at San Diego and Great Lakes would justify such a system. Orlando, Pensacola, and Meridian would have to receive support from a remote computer. For each site, MIISA estimated total one-time costs of $3,230,000, including equipment, building modifications, and power supply. A single software development expense exists of $90,700. There is an additional monthly maintenance and operation cost of $65,400 for each site. See Table 2 for details of these estimates. To install this fix just in NTC San Diego, Great Lakes, and NAS Memphis requires a one-time expense of $9,780,700 and monthly costs of $196,200; that is without providing support to Orlando, Pensacola, or Meridian.

Table 2

Cost Estimates for Alternative 2--Required CMI Functions Only

Item	Cost Estimate ($)
Alternative 2A--Redesign to Required CMI by Upgrading	
Central Site Upgrading: Unique to Centralized Processing	
One-time Costs:	
Equipment (second EVAL program)	150,000
Labor (development)	14,000
	164,000
Monthly Costs (Maintenance)	1,400
System Upgrade: Desirable Additions[a]	
One-time Costs:	
Equipment	211,000
Labor (development)	652,000
	863,000
Monthly Costs (Maintenance)	1,000
Total One-Time Costs for Alternative 2A	1,027,000
Alternative 2B--Redesign to Required CMI by Distributing	
Central Site: One-time Costs	
Equipment Development 3.5 man-years	90,700
Total One-time	90,700
Remote Site: One-time/Site	
Equipment: One-time	
Building modification (1)	80,000
Air conditioning	100,000
Power supply (1)	150,000
6620 Processor (256) (2) Datanets (2) Removable Disks (8) Tape Drives (4) 1200 LPM Printer 300 CPM Reader (1) 100-400 CPM Punch Communications channels (30)	2,900,000
Development	
Total One-time/Site	3,230,000
Remote Site: Monthly	
Maintenance: Monthly	
Contract	32,000
Field Engineer (2)	10,000
Operations: Monthly	
App. & Systems Programs (6)	14,400
Site coordinator (1)	1,700
Operators (6)	7,300
Total Monthly/Site	65,400

[a]These changes provide elements in communication system, centralized course coding, access monitor, second tape backup, moving ARTs to Level 6s, broadcast to terminals, and improved diagnostic monitors.

Alternative 3--Redesign System to Provide Required CMI Functions Combined with ADP for Group-Paced Instruction

This upgrade alternative involves redesigning the CMI system to support current required CMI functions combined with ADP supported functions for group-paced instruction. To provide a dimension of size to the group-paced portion of the system for costing purposes, the following parameters regarding the scope of support were selected. The selection was done by applying the function specifications from the previous report section to a set of potential school users of the ADP-GP system. A brief summary of ADP-GP system scoring specifications is that it will provide the capability for classes of students to have 100 item multiple-choice tests scored and summary data provided to the classroom level instructors within 15 minutes. Scoring will be performed so that no less than 300 tests will be graded per hour at any one school location. Instructor feedback will include a list of student SSNs or names, individual test scores and missed objectives, and an average class score. Of course, administrative support would also be provided. This capability can easily be required now with existing off-the-shelf equipment.

The potential schools for group-paced instruction ADP support were identified by reviewing the school's questionnaires. Schools selected were those that indicated some degree of interest in ADP support. This list of schools represents a hypothetical application of the ADP system and should not be viewed as a precise specification of schools that must have or that demand this support. The schools, their AOBs, and their geographic locations are presented in Table 3 to provide the reader with a perspective regarding the possible extent to ADP support for group-paced instruction that might be necessary or desired. This same list of schools will be used in comparing all upgrade alternatives involving group-paced instruction support. It should be mentioned that some of the schools on the list desire group-paced instruction ADP support, although they use a form of individualized instruction. These schools were included since some schools will indeed want to pursue this approach. It is difficult to predict how well it would work operationally.

Applying ADP-GP instructional system specifications to the school information contained in Table 3, the following estimates of testing requirements are derived.

1. There should be course file storage and evaluation processing at four sites presently supported by MIISA and at four sites not supported by MIISA (Gulfport, Meridian, Port Hueneme, and Mare Island).

2. There will be ART programs at three sites, average AOB of 1700 needing only 1 test/week in batches of 500.

3. There will be apprentice training at three sites, average AOB 763, requiring testing twice/week in batches of 100.

4. There will be a total of 28 "A" schools having approximately a total AOB of 6362, in an estimated 127 classes of 50 students each.

Each class requires testing 1/day.

As with Alternative 2, the approach to implementing this design concept can be to add to existing Mainframe capability at Memphis for all evaluation, or to distribute evaluation processing to the geographic site level. Accordingly, Alternative 3 is estimated for both conditions. These conditions are Alternative 3A--Redesign to Provide

Table 3

A Preliminary List of Candidate Schools for Group-Paced ADP Support

Location	School[a]	AOB[b]
Great Lakes, IL	Apprentice Training	891
	Fire Control Technician	425
	Gunners Mate	350
	Electronics Technician	1600
	Daily on Board	3266
	Academic Remediation/Week	1700
San Diego, CA	Apprentice Training	666
	Data Processor	125
	Hull Technician	160
	Messman School	400
	Daily on Board	1351
	Academic Remediation/Week	1700
Memphis, TN	Avionics Electrician	450
	Tradevman	28
	Advanced First Term Avionics	360
	Air Controller	294
	Aviation Ordnanceman	275
	Aviation Structural Mechanics	128
	Daily on board	1535
Orlando, FL	Apprentice Training	732
	Quartermaster	120
	Daily on Board	852
	Academic Remediation/Week	1700
Gulfport, FL	Builders School	120
Meridian, MI	Yeoman	245
	Storekeeper	115
	Disbursing Clerk	50
	Personnelman	120
	Aviation Storekeeper	100
	Administration	55
	Daily on Board	685
Port Hueneme, CA	Seven Small "A" Schools Total	370
Mare Island, CA	Data Systems Technician	352
	Total (Not including ART)	8531
	Total (ART/Week)	5100

[a]Schools were included if they indicated the mildest interest in ADP support and did not express any definitive or formal statement regarding acceptance of ADP.

[b]AOBs were obtained from a variety of sources and should be viewed only as estimates. ART AOBs were determined by dividing total ART load by the three locations.

Required CMI Combined with ADP-GP by Adding to Central Site Capability, and Alternative 3B--Redesign to Provide Required CMI Combined with ADP-GP by Distributing Processing to the Geographic Site. Again, the cost estimates are only preliminary and should be considered as an indication of the order of cost magnitude for each alternative.

Alternative 3A--Redesign for Centralized CMI with ADP-GP

This alternative involves developing and adding the ADP-GP system to the existing centralized CMI system. There are four major categories of costs to be considered: (1) incremental costs at the central site, (2) incremental costs at local sites already supported by CMI, (3) costs at sites not supported by CMI, and (4) costs per terminal. Table 4 provides detail for each cost area. Total costs are computed for the four CMI supported sites (San Diego, Memphis, Great Lakes, and Orlando) and the four non-CMI supported sites (Gulfport, Meridian, Port Hueneme, and Mare Island) and are presented in Table 5. Each terminal will support approximately 1000 students, assuming some scheduling among schools for test scoring, thereby requiring 13 terminals for the eignt sites as presented in Table 3.

Alternative 3B--Redesign for Distributed CMI with ADP-GP

This alternative will provide the ADP-GP system in conjunction with a distributed CMI system. Again, the four major cost categories include: (1) costs at the central site, (2) costs of local sites already supported by CMI, (3) costs of local sites not supported by CMI, and (4) terminal costs. The same parameters regarding the scope of ADP-GP support as were applied to alternative 3A apply to this alternative. The development costs for non-CMI sites assume that development for CMI locations has already been done. Table 5 also presents the summary costs for this alternative.

Table 4

Detailed Cost Breakdown for Alternative 3A--Redesign for Centralized CMI with ADP-GP

Item	Cost
Central Site: One-time	
Equipment	
Dual 66/80 (1)	300,000
128k Core (1)	105,000
Disk Drives (4)	132,000
CRT Terminals (4)	24,000
Tape Drive (1)	32,000
Datanet FEP (1)	200,000
	793,000
Development	
5 man-years	143,200
Total One-time Central Site	936,200
Central Site: Monthly	
Maintenance Operation	8,000
Total Monthly	8,000
Remote Site (Existing CMI)	
Equipment	
Level 6 (43) (approximately)	60,000
Development	
Total One-time Site (approximately)	60,000
Remote Site (Existing CMI): Monthly	
Maintenance	1,400
Line (approximately)	800
Operation	
Operator (1)	1,200
Site Coordinator (1)	1,600
Total Monthly Site (approximately)	5,000

Table 5

Cost Estimates for Alternative 3

Cost Item	One-time Cost ($)	Maintenance Monthly ($)
Alternative 3A--Centralized CMI with ADP-GP		
Central Site ADP-GP Costs		
Equipment	793,000	8,000
Development (5 man-years)	143,200	--
Remote Site (already supporting CMI) x 4		
Equipment--$60,000 x 4	240,000	20,000
Remote Site (not supporting CMI) x 4		
Equipment--$73,000 x 4	292,000	40,000
Terminal Cost		
Scantron	3,000	--
Printer/Keyboard	5,000	--
Link and Modems	500	200
Terminal Total Cost Each	8,500	x13
x 13 = Total Terminal Cost	110,500	2,600
Total Cost for ADP-GP System	1,578,700[a]	70,600
Central Site-Upgrade-from Alternative 2A	1,027,000	2,400
Total System Cost	2,605,700	73,000
Alternative 3B--Distributed CMI with ADP-GP		
Central Site		
Development Costs ($90,000 + $143,200)	233,200	--
Remote Site (already supporting CMI)		
From Alternative 2B to obtain distributed processing	3,230,000	65,400
For ADP-GP Equipment	63,000	5,300
Total per Site	3,293,000	70,700
x 3 Full Sites	9,879,000	212,100
Remote Site ADP-GP (no CMI support)		
Equipment	245,000	--
Development (2.5 man-years)	67,100	20,000
Total Costs per Site	312,100	20,000
x 5 (includes Orlando)	1,560,500	100,000
Terminal Costs (13)		
Total from Alternative 3A	110,500	2,600
Total System Cost--Alternative 3B	11,783,200	314,700

[a]The cost of $1,578,700 will provide only the ADP-GP system where designated in Table 3.

Alternative 4--Expanded CMI Combined with ADP-GP System

If a system redesign is necessary, then CNET should consider adding capabilities to the current CMI set of functions and combining those expanded capabilities with the functions necessary to provide group-paced instruction with ADP support. Because of the projected growth in computer requirements to satisfy the expanded CMI functions, it was determined that both addition to the Mainframe capability and distribution of processing to the geographic site would be necessary for successful system operation. Costing of this alternative was difficult due, in part, to the ambiguity of the requirement. The cost figure used was determined by using the high estimate for alternative 3B--Redesign to required distributed CMI with ADP-GP and adding increments for certain features. This estimate is shown in Table 6.

Table 6

Cost Estimates for Alternative 4--Expanded CMI

Item	Cost ($)
Alternative 3B--Total Cost	11,783,900
Resource allocation	55,000
Simple constructed response scoring	30,000
Coding of items to permit use of training validation program	145,000
Maintenance of detailed learning rate data	111,000
CRT terminals for on-line testing 200 x $1,000 each	200,000
Total	12,324,900

The expenditure for Alternative 4 would provide a thoroughly enhanced CMI system with ADP support for group-paced instruction and would use distributed processing to ensure system reliability. The expanded capabilities would include: a resource allocation system, simple constructed response test scoring, limited on-line testing, and a training program validation system that would enable relating fleet performance data with detailed school performance data. It should be emphasized that these cost figures are only tentative estimates for this alternative.

An Independent ADP-GP System

Although the task group was charged with exploring alternatives for upgrading the CMI system, an additional option open to CNET is adding independent ADP-GP systems. While we have not systematically explored options for independent systems, some rough approximations of costs were developed by MIISA. One independent system was assumed to require evaluation processing at one geographic location, with four remote schools: three schools operating four classes of 50 students each, with each student requiring 1 test/day, and one school operating with 700 students in classes of 100, each student requiring 2 tests/week. Data entry is to be assumed to be by machine-scorable answer sheets and all tests are to be 100 items.

Costs for this option amount to the estimated cost in Alternative 3B for one remote site ADP-GP system with no CMI support, and two terminal configurations:

Remote Site Equipment	$245,000
Development	67,100
Two Terminals @ $8,500 each	17,000
Total/Site	$329,100

There would be monthly maintenance costs associated with this option even though individual school personnel would operate the terminals. Since each terminal configuration is estimated to be $8,500, including the processor, printer and scoring device, that figure can be used when varying the number of terminals (i.e., students), supported at each school. This option is computed with a terminal for each 1000 group-paced students. The physical location of the schools might warrant additional terminals to save time transporting answer sheets from one building to another. Once the basic site investment has been made, the addition of terminals would be a minimal addition to the basic cost.

Comparison of Estimated Costs for CMI System Upgrade Alternatives

Using the information from the previous report sections, costs were estimated by MIISA staff for each of the six upgrade alternatives and the independent ADP-GP system. Total cost estimates for the six alternatives are presented in Table 7.

Table 7

Estimated Net Costs for Each of the CMI System Upgrade Alternatives

Alternative	Estimated Cost ($)
1--Short-term fix of CMI	54,000
2A--Redesign to required CMI at Cenral Site	1,027,000
2B--Redesign to Required CMI by distributing	9,780,700
3A--Redesign to required CMI combined with ADP-GP-Central Site	2,605,700
3B--Redesign to required CMI combined with ADP-GP-Distribute	11,783,200
4--Redesign to expanded CMI combined with ADP-GP	12,324,900
Independent ADP-GP system for one remote site	329,100

The changes MIISA has been implementing to improve the CMI system have been low-cost options primarily involving software and procedural changes. This approach has produced significant short-term (Alternative 1) improvement in RT and DT, with minimal cost ($54,000). A permanent solution that will ensure good system response as more students and courses are added is considerably more expensive, as can be seen by the estimates for all other options. The reader should recognize that all of these upgrade

alternatives will provide improvement to all the data processing requirements, including CMI, resident in the MIISA Memphis computer system. While the cost estimates are only approximations, they do provide "ballpark" figures for comparing alternative costs.

A notable factor is seen in comparing the estimates for the upgrade alternatives. That factor is that Alternative 3A--Redesign to provide centralized CMI with ADP-GP support, gives the maximum amount of system improvement with the lowest cost ($2.6 million). This is due to the fact that, by retaining centralization, it is not necessary to prepare and operate new sites for major computer systems. The redesign work that would accompany Alternative 3A should ensure proper system operation even as the CMI or ADP-GP systems are expanded.

Another point that is evident from Table 7 is that, even though costs for an expanded-capabilities CMI system (Alternative 4) are high, they are not that much higher than the costs for the alternatives (2B and 3B), which provide distributed processing for current CMI functions. The implication of that should be clear--any major move to upgrade the system by pursuing distributed processing should also involve expanding the CMI system's capabilities.

From consideration of Alternatives 2 through 4, it is clear that a major upgrading of the system to ensure continued good system operation is not a low-cost effort. If CNET cannot make the investment for the system upgrade, the CMI system can be operated with its present student and course load. Additional instructional support could be provided by independent ADP-GP systems. While the independent ADP-GP system probably would have a lower cost (study of independent systems was beyond the scope of this effort), the independent system would not permit as extensive student data retention or use. On the other hand, the independent systems would provide some ADP support for a broader range of schools at a relatively lower cost. To study the full range of possibilities, CNET should investigate the acquisition of very low-cost independent systems as a means of providing the ADP support for group-paced instruction.

RECOMMENDATIONS

During the course of this effort, the task group perceived several management actions that CNET should consider. These actions are contained in the following recommendations:

1. Continue the short-term upgrade approach to resolving RT and DT deficiencies. The system upgrade should include modifications that would provide no more than 5 percent DT at the learning center cluster, even when the host computer is down. The upgrade effort should add ADP support for group-paced instruction.

2. As part of the upgrade effort, task MIISA to perform the necessary analysis to identify and isolate precise causes of system malfunction as well as provide reliable CMI and group-paced instructional support and develop a computer system that will provide reliable CMI and the ADP support of group paced instruction. Only through this analysis can the proper CMI system be developed to permanently eliminate RT and DT problems and permit controlled growth of the instructional system.

3. Establish a CNET group to coordinate all CNET computer programs that effect data file structures and system operation on the CMI computer. This group would include staff responsible for MILPERSIS, NITRAS, Feedback Appraisal System, and all other data systems expected to use the MIISA system. (A form of this task has already been assigned to TAEG by CNET.)

4. Ensure that TPCs are knowledgeable about routine CMI reports for their courses by providing appropriate information through the existing CNTECHTRA system manager's office.

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APPENDIX A

INFORMATION SOURCES

INFORMATION SOURCES

The following is a list of participants in the first CMI System Upgrade Task Group meeting, 28-29 October 1980, at Pensacola, Florida:

Name	Organization	Code	Phone (Autovon)
Nick Van Matre	NPRDC	14	933-7122/2306
P. J. Scott	CNTT	N-8	966-5375
John H. Pinning	CNET	N-91	922-4201
Phyllis Salop	CNTT	N-8241	966-5375
Gordon A. Crawford	CNTT	N-824	966-5375
Charles E. Lindahl	NTEC	N-74	791-4491
Nancy Perry	CNET	022	922-3356
Gene Hooprich	CNET Liaison from NAVPERSRANDCEN	021	922-4582
Sallie Dowies	CNET	015	922-4545
Ed Scheye	CNET	N-915	922-4201
G. H. Holmes	CNTT	016	966-5148
Bill Ottendorfer	CNET	N-722	922-4101
Burt Thompson	CNET	N-93	922-4201
George T. Buzinki	MIISA (Branch Office Memphis)	34	966-5720
J. L. Ware	CNET	N-224	922-4402
M. A. Belto	CNET	N-94	922-4201
Joe Haslett	CNET	00A2	922-4447
Bob Milton	CNET	N-72	922-4101
Pat Lee	CNET	N-221	922-4402

CMI UPGRADE QUESTIONNAIRE RECIPIENTS

Questionnaires were sent to all Class "A" courses (including AP courses) taught at Naval Technical Training Command (NATECHTRACOM) activities under CNTECHTRA curriculum control. Questionnaires were also sent to all Training Program Coordinators who are responsible for at least one course meeting these qualifications.

Questionnaires were also sent to the following organizations:

CNTECHTRA, Code 016
CNTECHTRA, Code 017
CNTECHTRA, Code N-824
MIISA Branch Office, Memphis
Naval Education and Training Support Center Pacific, Code N-1
Naval Education and Training Program Development Center, Great Lakes

PERSONAL CONTACTS

The following personnel have participated directly in discussions related to the improvement of the Navy CMI system:

Navy Personnel Research and Development Center

- Dr. N. Van Matre
- Dr. K. Johnson

Chief of Naval Education and Training

Code N-9

- CAPT R. McKay
- Mr. J. Hasser
- Mr. E. Scheye
- Mr. H. Krukee
- Mr. B. Thompson

Code N-7

- Mr. W. Ottendorfer

Code N-5

- Dr. W. Scanland

Code 015

- CDR S. Kaiser
- Dr. W. Gager

Chief of Naval Technical Training

Code N-8

- CAPT P. Scott
- Mr. G. Crawford
- Ms. P. Salop
- CAPT H. Svoboda
- Mr. Wilson Thomas

Code 016

- CDR G. Holmes
- Mr. E. Evans
- Ms. D. Kalivoda
- Ms. M. Naulteus
- Ms. V. Reed
- LT S. Booth

Code 017

- Dr. N. Kerr
- Ms. L. Graham

Naval Education and Training Support Center Pacific, Code N-1

- Mr. H. Stevenson
- Dr. R. Kennedy

Mr. C. Taylor
Ms. L. Tergum
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Ms. R. Cobb
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Naval Education and Training Program Development Center, Great Lakes

Dr. J. Carey
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Mr. R. Bohatch

Management Information and Instructional Systems Activity, San Diego Detachment

Mr. C. Plough

Service School Command, San Diego

Mr. E. Trapp
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Memphis Information and Instruction Systems Activity, Branch Office, Memphis

Mr. C. Tilly
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Naval Weapon Center, China Lake

Mr. H. Hammerdinger

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Dr. C. Lindahl
Mr. A. Laing

Training Analysis and Evaluation Group

Dr. G. Micheli
Mr. M. Middleton
Mr. G. Hall
Mr. C. Morris

APPENDIX B

CMI SYSTEM UPGRADE REQUIREMENT ANALYSIS QUESTIONNAIRE

CMI SYSTEM UPGRADE REQUIREMENT ANALYSIS QUESTIONNAIRE

For: CNTT CMI Schools

The Navy Personnel Research and Development Center, CNET, CNTT, and their functional commands have established a Task Group to upgrade the CMI system. As an initial step, it is necessary to document deficiencies of the present system, planned expansions, and desired capabilities in order to arrive at the functional requirements for an improved CMI system. Your assistance in completing these questions as part of this Task Group is vital in this requirements analysis process. Please answer these questions as completely as possible. Your answers will be compiled with answers from others in the CMI community and formulated into a functional requirements document for review and revision by the CMI Upgrade Task Group.

This questionnaire is to be filled out for each course being taught by means of CMI. The responses should reflect opinions of course management, support personnel, and instructors, so please elicit comments from a wide range of personnel before consolidating them into a single set of responses. List your answers on separate paper.

1. Indicate name and location of course, CIN, and CDP(s).

2. List deficiencies or limitations in the current CMI system (e.g., frequent downtime, slow response, difficulty in course coding, or limitations on course design). Rate each deficiency as 1. Very Serious, 2. Moderately Serious, or 3. Minor.

3. List any new functions or capabilities that should be considered for the CMI system, including those that are already planned but not yet implemented. Indicate why each of the functions are needed.

4. Most CMI courses are designed in accordance with a set of guidelines, but some of those guidelines are based on limited information. Indicate areas in which you think the CMI guidelines might be improved if optimal procedures (e.g., different techniques for instructor intervention, for testing, or for providing remediation) could be determined.

5. Rate each of the following standard CMI reports in terms of its utility to (a) the instructor in the laboratory or learning center and (b) course or school personnel (administrative or managerial) outside the learning center. Use ratings of 1. Very Useful, 2. Moderately Useful, or 3. Not Useful.

	Utility Ratings	
Report	Learning Center Personnel	Administrative Managerial Personnel
Student Learning Guides		
Daily CMI Student Progress Reports		
Deficient Progress Report		
Accelerated Progress Report		
Trend Analysis Report		
Extra Study Report		
Learning Center Status Report		
CDP Distribution Report		
School Rosters		
Graduation/Drop Rosters		

Report	Utility Ratings: Learning Center Personnel	Utility Ratings: Administrative Managerial Personnel
Projected CMI Graduation Report		
Student Performance Summary		
Monthly Student Flow Report		
Module Distribution Report		
Response History Print		
Student Status Matrix		
Item Analysis Report		
Module Performance Analysis Report		

6. Have you had problems in receiving the above reports in a timely manner? Explain.

7. Do you ever need information from the CMI system other than that provided by the standard reports? If so, give examples. Have requests for additional information been satisfied, and if so, how long, on the average, has it taken?

8. How long should various kinds (specify) of CMI data be retained in order to meet your needs?

Answers to the following questions may vary from one CDP to another. If so, provide separate sets of answers, indicating for each the CDP or CDPs to which they pertain.

9. What is the maximum AOB under instruction?

10. How many new students, on the average, can you handle each week?

11. How many tests of any kind (module, lesson, comprehensive) does the average student submit to the scanner each day (estimate to one decimal point, e.g., 2.1)?

12. What is the average pay grade of all students (estimate to one decimal point, e.g., E-3.2)?

13. What is the average pay grade of all instructors (estimate to one decimal point, e.g., E-5.8)?

APPENDIX C

CNTT CMI SYSTEM MANAGEMENT (N-8): AREAS REQUIRING EMPIRICAL VERIFICATION

CNTT CMI SYSTEM MANAGEMENT (N-8): AREAS REQUIRING EMPIRICAL VERIFICATION

Empirical evaluations and/or literature searches with documentation of findings are needed in the following areas:

a. Criteria for selection of delivery system:

   (1) What factors determine whether a course should be individualized? (e.g., impact on retention and course length).

   (2) What factors determine whether a course should be developed for computer management?

   (3) What proportion of the tests within a course must be computer evaluated in order to make CMI cost effective? (e.g., what do the assignment, tracking, and managements capabilities alone do for a course in terms of cost savings, given the fact that certain administrative and development requirements will exist).

   (4) What are some workable models for determining cost effectiveness? How do development costs enter?

b. Guidelines for determining optimum learning center design and operation with respect to such factors as: (1) arrangement of carrels, training equipment, computer equipment, (2) integrated versus separated laboratories, (3) centralized testing centers, (4) student/instructor ratios in learning centers, laboratories, testing centers, (5) length of training day and number of training days per week. What is the impact on retention, contact hours and calendar days to course completion?

c. Identification of instructional design characteristics unique to computer-managed courses. Procedures for handling all design aspects that impact on effectiveness and efficiency including such facts as:

   (1) Design of total instructional package for a CMI module with respect to initial instructional material and remedial loops.

      (a) What is the optimum proportion of the target population that should be handled by the initial material and what proportion should be handled by computer-prescribed remedial loops?

      (b) What factors influence design with respect to proportion that should be handled by initial material?

      (c) Should CMI material be a lean straight path with practice and remediation handled by computer prescription or should CMI instructional material incorporate internal branching, significant practice, etc., with time gained by better students assimilating faster?

      (d) What is the impact of various types of instructional package design on retention and time to criterion?

      (e) Does number of remedials required to criterion affect retention?

(f) Does time to criterion effect retention?

(g) Does time at which remedial test is administered affect retention?

(h) What is the optimum size of segments of instruction prior to testing? What factors influence? What is the relation of size to retention and to course length?

(2) Design of computer prescribed remedial loops:

(a) What conditions justify assignment back to original material as remediation?

(b) How often should reassignment of original material occur?

(c) What factors determine incorporation of additional instructional resources as remediation? What Type? What conditions warrant such assignment? How frequently?

(d) When should instructors intervene in the learning process? What kind of intervention should take place?

(e) Should remedial testing of enabling objectives be handled the same as remedial testing of terminal objectives?

(f) Under what circumstances, if any, is remediation without retesting justified? (e.g., does failure to meet criterion on a minor enabling objective require a retest?)

(g) When should remedial tests be administered? Is there any difference in assigning all 1st remedial within a module at once as opposed to requiring remediation be completed on one problem area prior to assigning remediation on another area?

(h) When should questions be recycled?

(i) Does responding accurately only one time to one question per objective actually equate to mastery? Does responding to one remedial test immediately after remedial instruction equate to mastery?

(j) Should comps be required? Kind? When administered? Relation to retention? Does remediation on comps impact long term retention?

d. Structure of assignment, evaluation and feedback data provided to student on computer-generated learning guide (e.g., format, content, prediction and progress information).

e. Grading and/or ranking in criterion referenced courses. What should grade reflect? What factors should influence? Does requirement of grade or rank impact student performance?

f. Validation of course enabling objectives. Can some be omitted and terminals still be met? Can some be added (such as certain theory, or background type enablers) that will facilitate learning and either shorten time to criterion and/or increase retention?

g. IMI contingency plans. Type and phasing in and out of computer management.

h. Procedures for managing and operating CMI schools.

APPENDIX D

CNTT 016: SUGGESTED ADP SUPPORT REQUIREMENTS FOR LOCK STEP INSTRUCTION

CNTT 016: SUGGESTED ADP SUPPORT REQUIREMENTS FOR LOCK STEP INSTRUCTION

SYSTEM UTILIZATION PARAMETER

The ADP system will require the ability to manage students in courses with the following characteristics.

1. Courses taught in multiple locations.

2. Courses with lengths of one week to in excess of three months.

3. Classes varying in size from 12 to 60 students.

4. Courses with peak loadings as high as 17,000 students.

5. Courses with classrooms and laboratories located in different buildings at a single training site.

6. Courses with laboratories that contain multiple stations for the same purpose or labs containing as many as 218 unique lab stations.

7. Test schedules that range from fixed periods each day to as many as 12 tests occuring randomly throughout the instructional day.

8. Test design for specific purposes such as end-of-lesson or remediation and test banks which can be used either as end-of-lesson or as remediation tests.

9. Courses that contain less than 10 percent cognitive performance testing and courses that contain less than 10 percent cognitive testing.

10. Courses that require three or four shifts each day.

11. Courses in which the student moves from room to room for instruction, lab practice, performance or cognitive testing.

12. Course with multiple instructional tracks (sequences).

13. Courses that may be all group-paced, all self-paced or combinations of the two management strategies.

14. Courses where remediation is provided during the normal working hours or after hours. The extra study periods may be either before or after the normal shift hours.

15. Performance testing may be instructor evaluated or direct evaluation via an interface between operational equipment, trainers, or simulators and the ADP system.

16. Cognitive tests may be either recognition or recall questions including numerical computation where the process is as important as the correct answer.

17. Instructors staff may change frequently allowing for little or no preliminary instruction on how to interface with the ADP system.

18. Laboratory situations may create extreme heat or generate significant amounts of dust or other airborne particles.

19. Tests may need to be evaluated in 20 minutes or less to allow for in class remediation usually scheduled during the next instructional period.

SYSTEM FUNCTIONAL PARAMETER

1. Registration:

   a. Enroll student in the system
   b. Identify assignments (track, multiple tracks)
   c. Site identification
   d. Set-back/advance student
   e. Suspend student's file for time or grading purposes
   f. Change student data entered incorrectly
   g. Administratively drop student from course
   h. Provide roster for instruction

2. Progress Reports

   a. After each evaluation, list of students in various forms:

      (1) alpha students who passed
      (2) alpha students who failed
      (3) SSN students who passed
      (4) SSN students who failed
      (5) alpha students who missed test for authorized/unauthorized reasons
      (6) SSN students who missed test for authorized/unauthorized reasons

   b. Time needed to complete assignments, by individual module or entire course on class basis, individual student basis, or overall average.

3. Night Study (NS) Reports

   a. alpha list of students assigned to NS
   b. SSN list of students assigned to NS
   c. Areas requiring remedial instruction (list of most missed down to least missed items, e.g.)

4. Item analysis (by class, overall) for each test and overall Module Performance Analysis Report (by class, overall).

5. Performance Report--Overall student performance in school, i.e., graduation, attrition data by various categories (CDP, time, mental category, etc.)

6. Attrition Report--Number of and other pertinent data on students dropped in a particular timeframe.

7. Advance/Set-back Report

   a. List of students set-back/advanced
   b. Overall statistics, percentages of set-backs/advances by class

8. Response History (responses and time)--Individual module or entire course.

9. Student Matrix--Enables students track to be identified, modified, etc.

10. Student Status Report--Performance of individual student at any given time could include grades (if not pass/fail) made on each exam; any exams missed (if prerequisites are not set from one module to the next); number of NSs', etc.

11. Class Rosters (alpha/SSN/rate)

12. School Rosters (alpha/SSN/rate)

APPENDIX E

DESCRIPTIONS OF GENERAL INSTRUCTIONAL SYSTEM FUNCTIONS

DESCRIPTION OF GENERAL INSTRUCTIONAL SYSTEM FUNCTIONS

Function	Description
Delivery of Instruction:	The total set of activities involved in delivering instruction including providing subject matter by means of lectures, discussions, reading material, or student interaction with teaching machines or simulators.
Instructional Management:	The total set of activities that a schoolhouse must perform to guide a student through an instructional sequence and result in successful attainment of the learning objectives.
Student Registration	Student registration provides for the enrolling of a student into a school and course. It involves recording available student aptitude and demographic data. In the case of Navy individualized courses, registration also involves the specific assignment of the student to a particular study carrel.
Training Path Selection	Training path selection involves the selection and assignment to a student of a particular sequence of instructional modules or lessons within a course. While this activity can be automated in computer-based systems, the capability must exist for an instructor to override a pattern, module, or lesson assignment, assuming appropriate administrative approval.
Data Input: Student Instructor	Data input are those activities that involve a student or instructor submitting data into the instructional system. Inputs can involve answers to test questions or requests for feedback from the system regarding student performance, location in the course, or subsequent assignment. The input method depends upon the school and can vary from pencil and paper to the use of interactive computer terminals.
Test Scoring/Feedback	Test scoring consists of those activities related to evaluating the accuracy of student responses to knowledge or performance tests, questions, or exercises. The feedback function provides the student with knowledge of results of the test or performance evaluations.
Remediation/Prescription	The remediation/prescription function provides the student with explicit guidance regarding the study activities the student should engage in to overcome a within-module or lesson-learning objective deficiency, identified through the test scoring function.

Function	Description
Remediation/Prescription, Cont.	The indicated remedial activity is delivered through the test feedback function and includes a specific reference to the next test activity the student should perform following completion of assigned study activities.
Student Progress Tracking	Student progress tracking provides the capability to monitor the student's progress through a sequential course of instruction in terms of achievement and time. In addition to tracking progress, this function provides the capability of predicting student course completion time and forecasting graduation.
Management Information Reporting to: Student Instructor School Management Course Developers	This function consists of the reporting of student progress and achievement information to each level in the instructional system. This includes developing and sending reports of individual progress directly back to the student or instructor. It particularly includes summary reporting of information about a group of students to the instructor, school, or higher management levels or to the instructional program developers.
Instructional Support:	Instructional support functions are those activities that a school or course development organization must perform to ensure continued operation of the school, but they don't directly involve management of the instructional activities of the schoolhouse.
Instructional Program Development: Authoring Validation	Instructional program development includes those activities necessary for the design and authoring of instructional materials, and those activities associated with the validation of developed materials. The validation function includes assessing the validity of each course element, such as test items, lesson and module instructional materials. The validity assessment includes determining the time required for accomplishing a learning objective in relation to its contribution to acquisition of overall training objectives. This provides a determination of course efficiency, in addition to learning effectiveness.
Training Program Validation	Training program validation consists of assessing the extent to which the course as a whole meets the prescribed training objectives, in terms of actual job performance. This function also serves to determine the validity of different courses or course components in a sequence of courses. A component of this function involves the determination of the cost effectiveness of the training system as a whole.

Function	Description
Resource Allocation Student Scheduling Instructor Scheduling Equipment Scheduling Equipment Inventory	Resource allocation refers to those activities necessary for the scheduling of students, instructors, and equipment and supplies into the school to maintain an effective balance of resources and optimal student flow through the course. A sub-function involves maintaining an inventory of equipment and supplies and handling the procurement process associated with assuring adequate available supplies.
Instructional System Security	System security is the function that maintains the integrity of the instructional system and consists of those activities that ensure maintaining the physical premises and the secrecy of test questions and student records. For the basic school this function may only involve the locking of an instructor's desk, while computer-based systems require passwords and computer security instructions to keep tests and records and programs from being compromised.
Historical Record Keeping	Historical record keeping consists of those activities necessary to maintain the desired records for evaluative purposes. This function is distinct from the particular evaluation activity self.

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